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# THE BRITISH MUSEUM
# (NATURAL HISTORY)

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## ZOOLOGY

Vol. 26

1973–1974

BRITISH MUSEUM (NATURAL HISTORY)
LONDON: 1975

## DATES OF PUBLICATION OF THE PARTS

| | |
|---|---|
| No. 1 | 1 November 1973 |
| No. 2 | 15 November 1973 |
| No. 3 | 7 February 1974 |
| No. 4 | 22 May 1974 |
| No. 5 | 24 May 1974 |
| No. 6 | 7 June 1974 |

ISSN 0007–1498

*Printed in Great Britain by John Wright and Sons Ltd. at The Stonebridge Press, Bristol BS4 5NU*

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NATURAL HISTORY

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## STUDIES ON AFRICAN CYPRINIDAE
## PART II

K. E. BANISTER

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*Pp.* 1–148; 105 *Text-figures*

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THE BULLETIN OF THE BRITISH MUSEUM (NATURAL HISTORY), *instituted in* 1949, *is issued in five series corresponding to the Departments of the Museum, and an Historical series.*

*Parts will appear at irregular intervals as they become ready. Volumes will contain about three or four hundred pages, and will not necessarily be completed within one calendar year.*

*In* 1965 *a separate supplementary series of longer papers was instituted, numbered serially for each Department.*

*This paper is Vol.* 26 *No.* 1 *of the Zoological series. The abbreviated titles of periodicals cited follow those of the World List of Scientific Periodicals.*

*World List* abbreviation:
*Bull. Br. Mus. nat. Hist.* (Zool.)

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TRUSTEES OF
THE BRITISH MUSEUM (NATURAL HISTORY)

*Issued* 1 *November*, 1973 *Price* £6·95

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## PART II

*By* KEITH EDWARD BANISTER

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## SYNOPSIS

All the previously described species and subspecies of the large *Barbus* (the species usually described as possessing parallel striae on their scales) from east and central Africa are examined. The area under consideration is bounded in the north by the mouth of the Nile and in the south by the Zambezi system. The western boundary is the upper reaches of the Congo system adjacent to the rift valley and the eastern boundary is the coast.

It is shown that many nominal species can be synonymized when a sufficiently large series of specimens is available to show that the characters formerly used to distinguish them form a continuous series within a polytypic species. Consideration is given to the taxonomic value of these characters and their variability is demonstrated. Particularly variable are the lips, body depth and head length. This is a reflection both of eco-phenotypic factors and of allometry.

The quaternary palaeogeography of this part of Africa is considered in an attempt to elucidate the present distribution of certain species.

Two former subspecies are raised to specific rank (*Barbus longifilis* and *Barbus paucisquamatus*) and one new subspecies is described (*Barbus intermedius australis*). Two replacement names are included ; *Barbus lapsus* for *Barbus babaulti* Pellegrin 1935 and *Barbus susanae* for *Barbus gregorii* Norman 1923.

## INTRODUCTION

THIS revision was initiated by an unsuccessful attempt to identify satisfactorily the large *Barbus* species collected by the Sandhurst Army College Ethiopian Expeditions of 1964 and 1966. The use of the keys in Boulenger's *Catalogue of African Freshwater Fishes* (1911–1916) showed that some species were so imprecisely defined that an individual specimen could be assigned to any one of several different species. Many of the species described by early workers on African *Barbus* species were based on one or a few poorly preserved individuals, and it is only now, when sufficient material is available, that an attempt can be made to redefine some species allowing for growth and natural variation.

Worthington (1932a) demonstrated that lip shape, formerly considered a significant specific character in the large *Barbus* species, was extremely variable. This aspect was greatly extended by Groenewald (1958) who was able to demonstrate the great range in *Barbus* species lip form engendered by the environment in certain species. In the course of this work he cast doubts upon the validity of the inclusion of certain species in the closely related genus *Varicorhinus*.

Jubb (1961, 1963, 1965, 1967a, 1968), Crass (1960) and Jackson (1961) have continued this study and have partially confirmed Worthington's (1932a) views on the variability of the large *Barbus* species. *Barbus marequensis* A. Smith has been shown by the South African workers' efforts to be a widespread and variable species.

An analogous situation exists in eastern and central Africa. Many large *Barbus* species have been described, but as more specimens were collected the boundaries between the species became obscured as new data rendered the old specific definitions untenable. New descriptions of species must, therefore, incorporate the range of intraspecific variation if the definition of the species is to have any validity and reflect the status of the populations in the field.

Several authors, e.g. Worthington (1932a), Pellegrin (1935) and Bini (1940), have described *Barbus* subspecies and varieties. The subspecies considered in this paper conform to the definition of Mayr (1949) although it has not always been possible to conform to the '75 per cent distinguishable' convention suggested by Mayr. Geographical isolation, on its own, without any supporting morphological or colour differences is not considered sufficient justification for the establishment of subspecies. I would like to have used Mayr's definition of superspecies. I am unable to do so as I cannot prove that the species I consider to form such taxa would constitute a monophyletic assemblage and hence I use the terms supra-specific complexes or groups. This does not assume monophyly although hopefully one day it may be proved.

There are still many problems that I have been unable to consider in this work ; ecological information is only rarely available (and the effect of the environment could well be an important factor influencing the phenotypic variation) and colour patterns are based almost entirely on preserved specimens.

This revision remains, therefore, essentially that of a museum worker, but it is very possible that further information from live specimens may lead to the establishment of subspecific taxa especially in the widespread species.

There are some geographical areas that have presented many difficulties, particularly where watersheds are close together. By unfortunate quirks of geography or international politics these areas are inadequately sampled and some of my subsequent conclusions about the status of the specimens must be regarded as tentative. These problems are mentioned in the text. A lot of time was spent in trying to pin-point the localities where specimens had been collected. The localities were often given the name of the local village, but these villages were frequently only temporary settlements of nomadic tribes. Many town and village names were changed when countries were occupied or invaded and collections made at the same site under different regimes bear different locality names. Where such localities have been traced they are incorporated in the gazetteer (Appendix 2) and as much information as I can give, in physiographical details or in grid references, is included.

The limits of distribution of the species described in this paper are from the Nile in the north down to, but not including, the Zambezi system. The eastern limit is the eastern coast of Africa and the western limit is the western rift valley. Some species whose range extends to the west of the rift valley, into the Upper Congo are included, e.g. the Upper Congo species *Barbus mirabilis* is included because of its relationship with the species that live in the area covered.

The arrangement of species in the descriptive part of the text is alphabetical.

## Notes on counts and measurements

The standard length (S.L.) was taken in the usual manner (see Banister 1972). The lateral line count (LL) was taken from the first pore-bearing scale behind the head to the scale lying lateral to the end of the hypurals. The body depth (D) is the maximum body depth, usually to be found just in front of the dorsal fin. The anterior limit for the head length (H) and snout length (Snt) was the premaxillary symphysis, with the premaxillae retracted. In 'rubber-lipped' fishes this measurement was only taken with difficulty. The posterior limit for the snout is the anterior margin of the orbit. The term mouth width (MW) is a shorthand notation for the width of the lower jaw at its widest point. The pectoral fin length (Pct.) is the total length of the fin, measured in a straight line from the base of the first ray to the distal extremity of the fin. The measurement is taken in this manner because of the ease of so doing with dial calipers, which were used on all fish except the smallest when dividers were used. The caudal peduncle length (CPl) is the horizontal distance from the posterior angle of the base of the last anal fin ray to the end of the hypurals, and the caudal peduncle depth (CPd) is the least depth of that part. The interorbital width (IO) was measured as the least distance apart of the bony edges of the interorbital space. The eye diameter (I) had to be taken as the horizontal diameter of the orbit ignoring the skin around the eye. This was because in many of the more ancient specimens the skin had markedly shrivelled away from the eye and the measurements would not otherwise have been comparable with those of recently preserved fish. The dorsal spine (DSp), strictly the last unbranched ray in the dorsal fin, was measured from its base to the proximal articulation (if any were present). The reason for this was to overcome the inaccuracy caused by damage to the flexible tips and, although an arbitrary point, experience showed it to be moderately consistent. Severely damaged spines were not measured. With any measurements which were repeatable on both sides of the fish (e.g. anterior barbel, Ab, or posterior barbel, Pb), the larger was taken except in a few cases when gross deformity was obvious.

The majority of measurements were taken to the nearest millimetre. The exceptions were some measurements made on small fishes ; these were taken to the nearest half millimetre. The limits of accuracy do not justify calculations taken to more than one place of decimals. The mean is symbolised by $\bar{x}$, the standard deviation by s.d., the standard error by s.e. and the mode by m. The height of a pharyngeal tooth is taken as the parameter at 90 degrees to the plane of the pharyngeal bone, the length of the pharyngeal tooth is the parameter of a transverse section of the tooth in the plane of the anterior edentulous process and the width of the tooth is the parameter at 90 degrees to the length. The code letters for the museums from whose collections the specimens came are listed at the start of Appendix 4.

All the drawings of the pharyngeal bones show 1) the bone directly from above with the bone lying flat on its edentulous surface and 2) an occlusal view of the inner row of teeth with the bone at 90 degrees to the position in 1), i.e. drawn from above with the bone mounted vertically on its posterior edentulous process. For convenience these are referred to in the text and figure captions as, respectively, the dorsal and lateral views.

## ***Barbus acuticeps*** Matthes 1959

*Barbus acuticeps* Matthes, 1959, *Folia scient. Afr. cent.* **5** (3) : 62 ; Matthes, 1962, *Annls Mus. r. Afr. cent. Ser. 8vo* **111** (2) : 81, pl. 1, fig. b.

HOLOTYPE. A fish of 210 mm S.L. from the Nyawarongo river, Lake Rugwero, Rwanda. Specimen no. M.A.C.T. 130313.

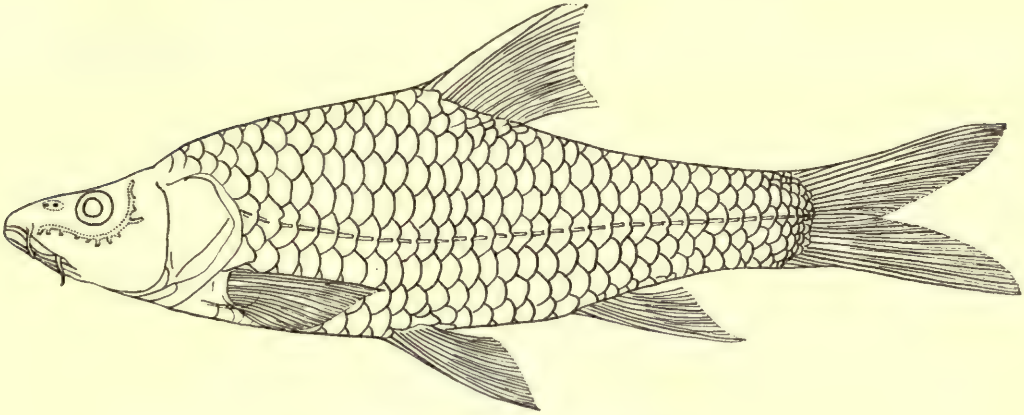


FIG. 1. *Barbus acuticeps* from Matthes 1962.

DESCRIPTION. The description is based on nine specimens, the holotype, four paratypes (130310–12, 130314) of S.L. 43 mm, 121 mm, 92 mm and 202 mm respectively, and four other specimens M.A.C.T. 12910 (S.L. 131 mm), 13045–6 (119 and 116 mm S.L.) and 172421 (242 mm S.L.).

My standard length measurements are consistently shorter than those of Matthes (1962). I attribute this to different concepts of standard length.

| | n | x̄ | s.d. | s.e. | range |
|---|---|---|---|---|---|
| L | | | | | 43 –242 mm |
| D | 9 | 27·8 | 4·1 | 1·3 | 23·6–33·7 |
| H | 9 | 28·7 | 3·5 | 1·2 | 24·8–35·6 |
| I | 9 | 6·3 | 1·3 | 0·5 | 4·3– 9·3 |
| IO | 9 | 7·1 | 1·6 | 0·5 | 4·7–10·4 |
| MW | 8 | 5·8 | 1·3 | 0·5 | 4·5– 7·9 |
| Pct | 8 | 21·7 | 2·0 | 0·7 | 19·5–25·8 |
| CPl | 9 | 17·6 | 1·7 | 0·6 | 15·2–20·6 |
| CPd | 9 | 11·4 | 1·5 | 0·5 | 9·3–13·7 |
| Snt | 8 | 8·3 | 1·2 | 0·4 | 6·4–10·4 |
| Ab | 8 | 4·8 | 2·1 | 0·8 | 2·2– 6·9 |
| Pb | 8 | 5·6 | 2·3 | 0·8 | 2·9– 8·6 |

All measurements are expressed as percentages of the standard length.

The dorsal profile of the head is concave and a pronounced nuchal hump is present. The snout is pointed and the mouth slopes upwards. Otherwise the body and head shape resembles that of *Barbus altianalis* (*sensu lato*) and *Barbus ruasae*.

*Squamation.* It was not possible to obtain scale counts for the two smallest specimens. The scales have parallel striae and there are 27 (f.3), 28 (f.1), 29 (f.2) or 30 (f.1) scales in the lateral line. Between the dorsal mid-line and the lateral line there are 4·5 (f.5) or 5·5 (f.2) scale rows. In only two specimens was it possible to count the number of scale rows between the lateral line and the ventral mid-line, in both there are 5·5 rows. Between the lateral line and the base of the pelvic fin there are 2 (f.2), 2·5 (f.2) or 3 (f.1) scale rows. There are 12 scales encircling the caudal peduncle.

*Dorsal fin.* There are 8 (f.5) or 9 (f.3) branched rays. The fourth unbranched ray is ossified into a smooth, straight spine ($\bar{x}$ = 22·3 ; s.d. = 2·9 ; s.e. = 1·0 ; range 17·4–26·7). There is no sheath of scales at the base of the dorsal fin. The dorsal fin origin is slightly behind that of the pelvic fins. The *anal fin* has three simple rays and five branched rays.

*Gill rakers.* In five specimens examined, three had eight gill rakers on the lower limb of the first gill arch, the other two had ten and eleven.

*Pharyngeal bones and teeth.* I have not been able to study the pharyngeal bones but they were described by Matthes (1962) as 'Falciformes, non soudés, attachés l'un à l'autre par une symphyse ligamenteuse. Ils sont peu élargis et les branches montantes sont comprimées et assez grèles. Dents pharyngiennes obliquement tronquées et légèrement excavées, avec une pointe antérieur recourbée vers l'arrière, en 3 rangées au nombre de 2, 3, 5–5, 3, 2, les 2me et 3me dents de la rangée interne un peu plus fortes.'

*Coloration.* Described by Matthes (1962) as completely silvery with pearly reflections when alive. The operculum is yellowish with metallic glints, the eye is yellowish, the pupil ringed with gold. The fins are clear, yellowish ; the dorsal and caudal are greyish, yellowish and salmon-pink.

DISTRIBUTION. Four of the specimens came from the Nyawarongo river (to the north of Lake Rugwero), the fifth specimen in the type series came from the falls of Rusumu on the Kagera (Rwanda). The other specimens came from Lake Ihema, Kagera ; the Nyabugogo river (an affluent of the Lusine river, Burundi) and from Matale (? Burundi).

DIAGNOSIS AND AFFINITIES. *Barbus acuticeps* is dubiously distinct from *Barbus altianalis*. The principal differences between *Barbus acuticeps* and *Barbus altianalis* are 1) the concave dorsal profile of the head and the nuchal hump of the former species, 2) the antero-dorsal gape of the mouth of the former species which contrasts with the, usually, subterminal mouth in *Barbus altianalis*, 3) fewer gill rakers in *Barbus acuticeps* (8–11) compared with 10–14 (most frequently 11–13) in *Barbus altianalis*, 4) slightly fewer scales in the lateral line series in *Barbus acuticeps* (27–30) compared with 28–36 (most frequently 30–34) in *Barbus altianalis*, 5) a longer dorsal fin spine in *Barbus acuticeps* ($\bar{x}$ = 22·3, range 17·4–26·7) compared with $\bar{x}$ = 16·9, range 9·0–30·4, in *Barbus altianalis*.

It must be remembered that *Barbus acuticeps* is known from very few specimens and that more are necessary to confirm whether or not its continued separation from *Barbus altianalis* is justified.

*Barbus ruasae* (p. 109) also from Rwanda to some extent resembles *Barbus acuticeps* in general appearance but is readily separable on the lower number of scales in the lateral line series [25 (f.9), 26 (f.1)]. The pharyngeal teeth of *Barbus acuticeps* are less molariform than those of *Barbus ruasae*, but this could be the result of diet. *Barbus ruasae* does not have a mouth opening antero-dorsally. *Barbus acuticeps* is considered here to belong to the *Barbus intermedius* group (see p. 128).

### ***Barbus alluaudi*** Pellegrin, 1909

*Barbus alluaudi* Pellegrin, 1909, *Bull. Soc. zool. Fr.* **34** : 155 ; Pellegrin, 1910, *Mem. Soc. zool. Fr.* **22** : 287, pl. 14, fig. 2 ; Banister, 1972, *Bull. Br. Mus. nat. Hist.* (Zool.) **24** (5) : 261–290.

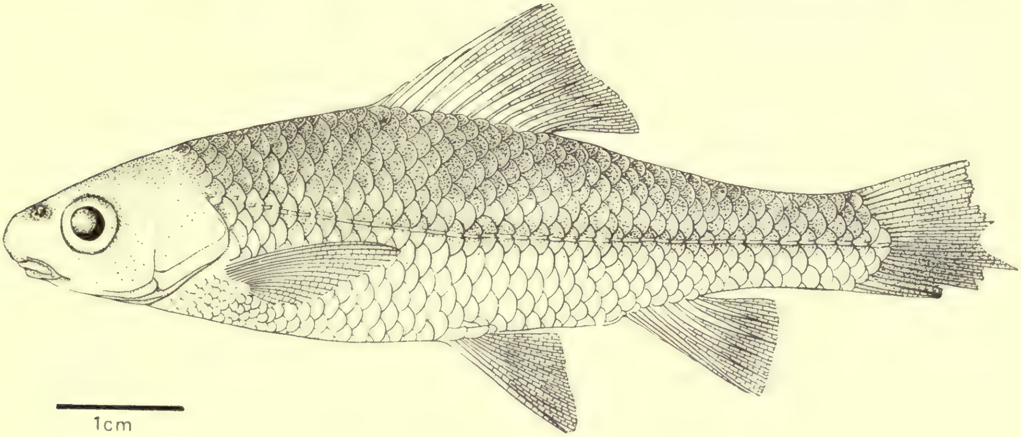


FIG. 2. *Barbus alluaudi* Holotype.

This specific name has, I believe, been given to hybrids between *Barbus somereni* and *Varicorhinus ruwenzorii* [Banister (1972)].

### ***Barbus altianalis*** Boulenger, 1900

*Barbus altianalis* Blgr., 1900, *Ann. Mag. nat. Hist.* (7) **6** : 479 ; Blgr., 1901, *Trans. zool. Soc. London*, **16** : 144, pl. 13, fig. 1 ; Blgr., 1911, *Cat. Afr. Fish* **2** : 36 ; Norman, 1925, *Occ. Pap. Boston Soc. nat. Hist.* **5** : 189.

*Barbus altianalis altianalis* : Worthington, 1932, *J. Linn. Soc.* (Zool.) **38** (258) : 124–127 (Lake Kivu and Ruzizi river specimens) ; Poll, 1953, *Result. scient. Explor. hybrobiol. Lac Tanganika* (3) **5A** : 88.

*Barbus altianalis radcliffii* : Worthington, 1932, *ibid.* : 124–127 (Lake Victoria specimens).

*Barbus altianalis eduardianus* : Worthington, 1932, *ibid.* : 124–127 (Lakes Edward and George specimens).

*Barbus altianalis var. labiosa* Pellegrin, 1935, *Revue Zool. Bot. afr.* **28** (3) : 376–385 (only the holotype, from Lake Kivu).

*Barbus* (*Labeobarbus*) *nedgia* : Hilgendorf, 1888, *Sber. Ges. naturf. Freunde Berl.* : 88 (from Lake Victoria, misidentification, not *Barbus nedgia* Rüppell ; *fide* Blgr., 1911).

*Barbus eduardianus* Blgr., 1901, *Ann. Mag. nat. Hist.* (7) **8** : 12 ; Blgr., 1907, *Fish Nile* : 230, pl. 43, fig. 2.

*Barbus fergussonii* Blgr., 1901, *Ann. Mag. nat. Hist.* (7) **8** : 12 ; Blgr., 1907, *Fish Nile* : 230, pl. 43, fig. 1.

*Barbus radcliffii* Blgr., 1903, *Ann. Mag. nat. Hist.* (7) **12** : 218 ; Blgr., 1907, *Fish Nile* : 212, pl. 37, fig. 1.

*Barbus marequensis* : Pellegrin, 1904, *Mem. Soc. zool. Fr.* **17** : 17 (misidentification, not *Barbus marequensis* Smith, specimen from Kavirondo, Lake Victoria, *fide* Blgr., 1911).

*Barbus lobogenys* Blgr., 1906, *Ann. Mag. nat. Hist.* (7) **17** : 435 ; Blgr., 1907, *Fish Nile* : 210, pl. 36, fig. 1.

*Barbus bayoni* Blgr., 1911, *Annali Mus. civ. Stor. nat. Giacomo Doria* (3) **5** : 77.

*Barbus kivuensis* Pappenheim, 1914, *Wiss. Ergebn. dt. ZentAfr. Exped.* Zool. (3) **5** : 237.

*Barbus gregorii* : Blgr., 1916, *Cat. Afr. Fish* **4** : 230 (only the specimens from the Malawa river).

*Barbus pietschmanni* Lohberger, 1929, *Anz. Akad. Wiss. Wien* **66** : 92–94.

*Barbus hollyi* Lohberger, 1929, *Anz. Akad. Wiss. Wien* **66** : 92–94.

*Barbus obesus* Worthington, 1929, *Proc. zool. Soc. Lond.* (3) : 433.

*Barbus kiogae* Worthington, 1929, *Proc. zool. Soc. Lond.* (3) : 434.

*Barbus longirostris* Worthington, 1929, *Proc. zool. Soc. Lond.* (3) : 435.

NOTES ON THE SYNONYMY. *Barbus altianalis* is a widespread species occupying three isolated areas. The fish of each of these areas, although in morphometric characters scarcely different modally from one another, were given subspecific status by Worthington (1932a).

*Barbus altianalis* was first described from two fish from Lake Kivu and one from the Ruzizi river. All are large specimens ; the smallest (from the Ruzizi) has a S.L. of 306 mm while the other two are 331 and 406 mm.

*Barbus eduardianus* was described from one large fish from Lake Edward and *Barbus fergussonii* from two small fishes from the same lake. The latter two specimens have unusually shallow bodies when compared with equal-sized specimens even from the same waters.

*Barbus radcliffii* was based on a skin from Lake Victoria. *Barbus lobogenys* was based on two 'rubber-lipped' specimens from Lake Victoria. *Barbus bayoni* was described from a very large fish (S.L. 640 mm) from near Jinja on Lake Victoria. *Barbus pietschmanni* and *Barbus hollyi*, both from Lake Victoria, were based respectively on one and two specimens.

The holotype and sole example of *Barbus obesus* from Lake Kioga (fig. 3) is a fat, deep-bodied fish with a low number of lateral line scales (28). The scales are slightly lobed and the specimen gives the impression of a rather deformed individual. The two syntypes of *Barbus longirostris* (fig. 4) from the same locality are large specimens (388 and 410 mm S.L.) with shallow bodies and heads longer than the mean for the species. They are linked with more typical *Barbus altianalis* by members of the type series of *Barbus kiogae*. No morphometric or meristic way can be found for separating the populations from Lake Kioga from those of Lake Victoria. Large fish from Lake Victoria not infrequently approximate to the facies of *Barbus longirostris* and *Barbus kiogae* (P. H. Greenwood : pers. comm.). The description of the holotype of *Barbus kivuensis* differs hardly at all from that of *Barbus altianalis* from the same lake.

Norman (1925) commented that the specimens of *Barbus altianalis* from Lake Edward, collected by Dr John Phillips, were identical with *Barbus radcliffii* from Lake Victoria.

Worthington (1932a) was able to gather together sufficient material to realize that a single species is found in the three areas, *Barbus altianalis altianalis* from Lake Kivu and the Ruzizi river ; *Barbus altianalis radcliffii* from Lake Victoria and the

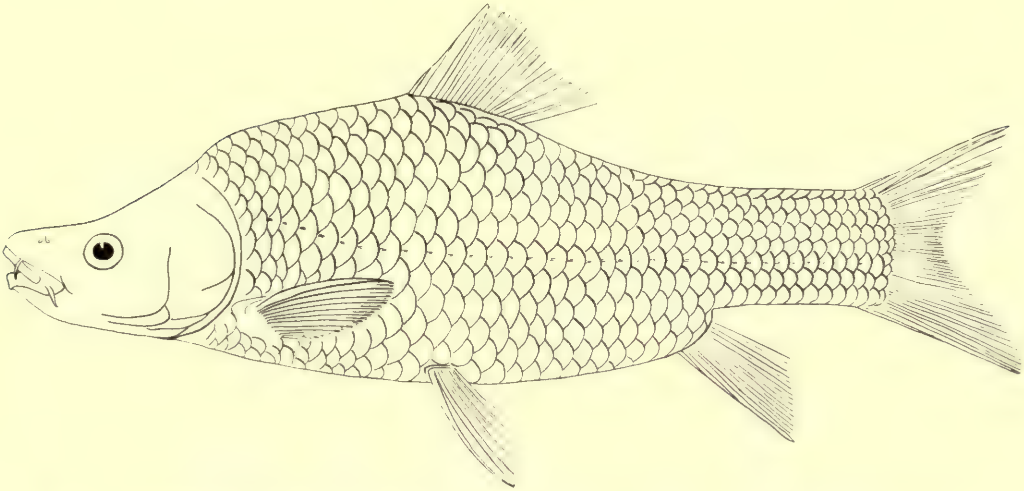


FIG. 3. *Barbus altianalis* (Holotype of *Barbus obesus* re-drawn from Worthington 1929).

Victoria Nile ; and *Barbus altianalis eduardianus* from Lakes Edward and George and the Kazinga channel.

Boulenger's *Barbus radcliffii, Barbus lobogenys* and *Barbus bayoni* were synonymized by Worthington (1932a) in *Barbus altianalis radcliffii,* and *Barbus eduardianus* and *Barbus fergussonii* in *Barbus altianalis eduardianus.* An important conclusion of Worthington's work was the realization that *Barbus* species can exhibit remarkable intraspecific variation, particularly with regard to the development of the lips and he suggested that further extensive synonymizing might be necessary when larger samples became available. However, he did not synonymize the species he described from Lake Kioga because with the material at his disposal they remained apparently distinct. Scatter diagrams comparing body depth and head length of the Lake Victoria and Lake Kioga populations are shown below (figs. 6 and 7). Pellegrin (1933, 1935) described several varieties of *Barbus altianalis* from Kivu region : only one of these is considered here as belonging to this species (for the others see under *Barbus caudovittatus, Barbus paucisquamatus* and *Barbus longifilis*). A slight element of confusion was introduced by Pellegrin's use of 'Région du Kivu' ; this is not always the Lake Kivu basin but in some cases refers to sites in the Congo system.

Greenwood (1966) synonymized *Barbus pietschmanni* and *Barbus hollyi* with *Barbus altianalis radcliffii.*

I am retaining Worthington's three subspecies, certainly on geographical grounds but also because of the consistent colour differences between the *Barbus* subspecies of Lake Victoria and those of Lake Edward–George. Dr P. H. Greenwood (pers. comm.) has noted that specimens of *Barbus altianalis eduardianus* of over 100 mm S.L. from Lake Edward–George have pink caudal fins whereas those of Lake Victoria never do. I have no information about the specimens from Lake Kivu.

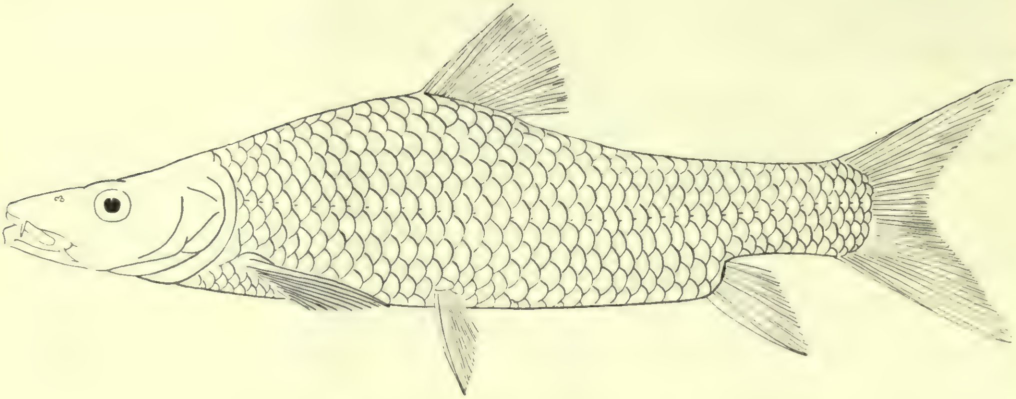


FIG. 4. *Barbus altianalis* (figured specimen of *Barbus longirostris*, re-drawn from Worthington 1929).

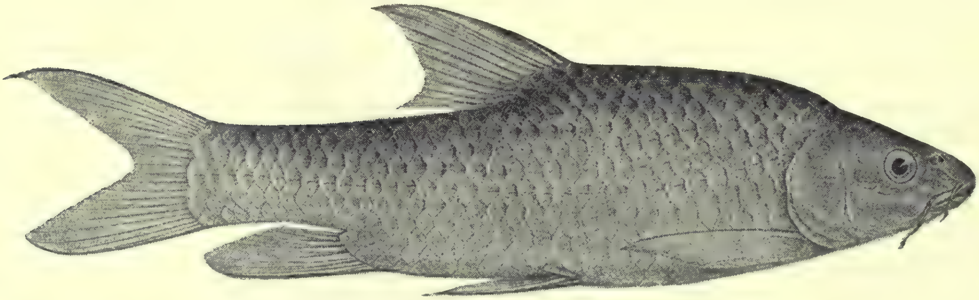


FIG. 5. *Barbus altianalis altianalis* (Holotype from Boulenger 1911a).

LECTOTYPE. A fish of 331 mm S.L. from Lake Kivu (one of the three in Boulenger's type series). B.M. (N.H.) Reg. No. 1906.9.6 : 13.

DESCRIPTION. The description is based on a total of 213 specimens ; 15 of these are from Lake Kivu and the Ruzizi river (size range 46–410 mm S.L.), 130 are from Lakes Edward and George, the Kazinga channel and Lake George feeder streams (size range 68–436 mm) and 68 are from Lakes Victoria and Kioga (size range 99–640 mm). The combined morphometric data for all three populations are as follows, and include all the holotypes except for *Barbus pietschmanni* and *Barbus hollyi*.

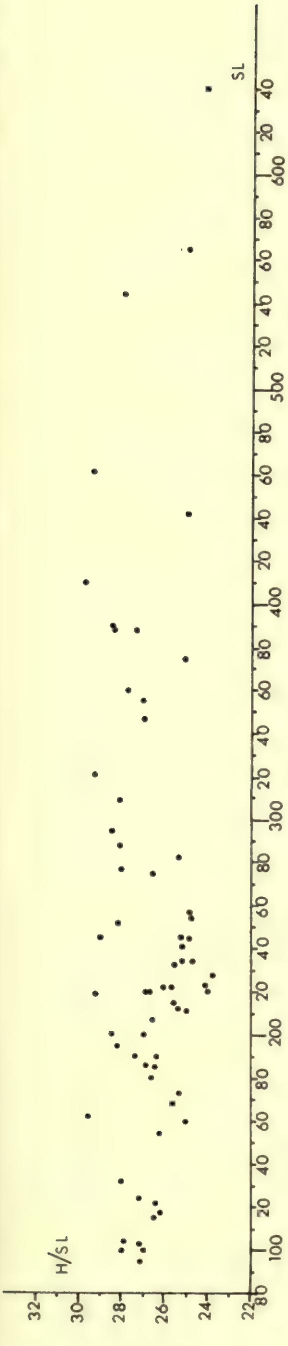


FIG. 6. Scatter diagram of the head length as a percentage of the standard length against the standard length for the Lakes Victoria and Kioga populations of *Barbus altianalis radcliffi.*

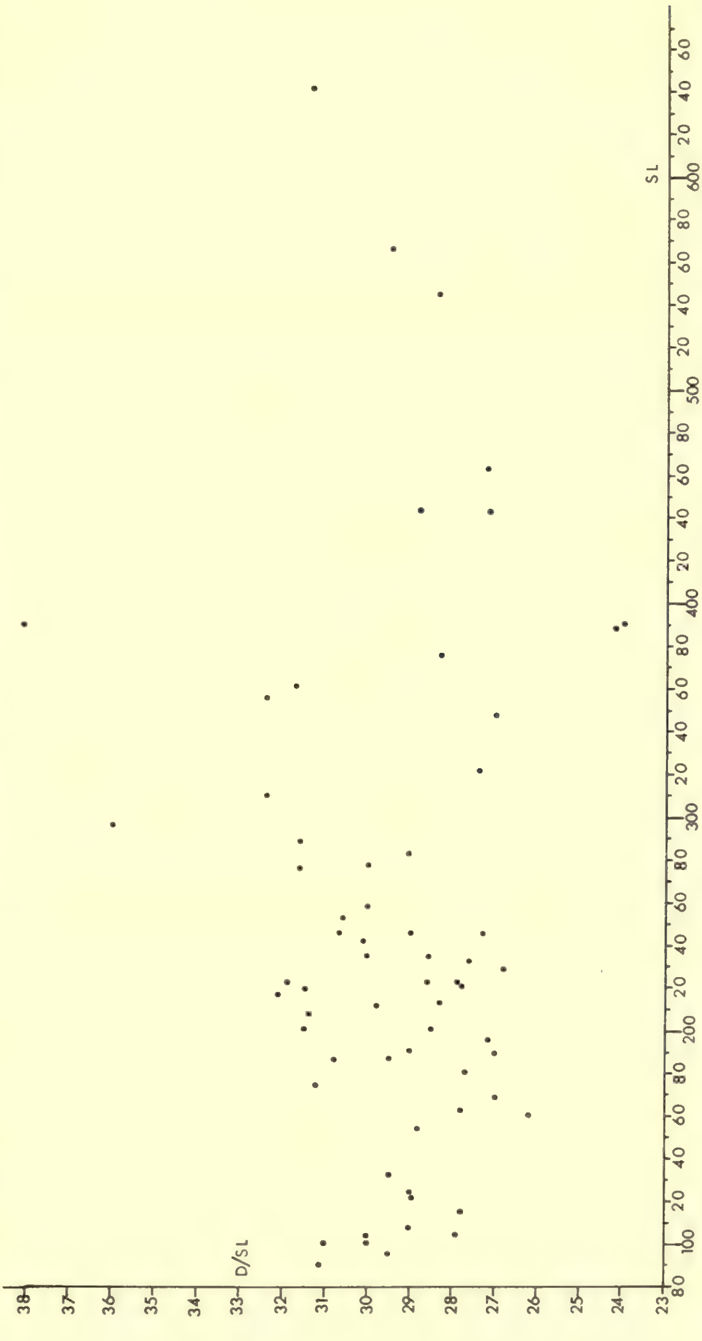


FIG. 7. Scatter diagram of the body depth as a percentage of the standard length against the standard length for the Lakes Victoria and Kioga populations of *Barbus altianalis radcliffi.*

| | x̄ | s.d. | s.e. | range |
|---|---|---|---|---|
| L | | | | 46 –640 mm |
| D | 29·4 | 2·4 | 0·4 | 22·4–37·4 |
| H | 26·1 | 1·6 | 0·1 | 22·5–31·4 |
| I | 7·6 | 1·0 | 0·1 | 4·1–11·5 |
| IO | 8·4 | 1·0 | 0·7 | 6·4–11·2 |
| MW | 6·2 | 0·9 | 0·1 | 4·7– 9·5 |
| Pct | 21·8 | 1·4 | 0·1 | 17·5–25·0 |
| CPl | 16·9 | 1·4 | 0·1 | 13·1–19·8 |
| CPd | 12·0 | 0·9 | 0·1 | 9·5–16·2 |
| Snt | 8·3 | 0·8 | 0·1 | 5·8–10·9 |
| Ab | 4·3 | 1·1 | 0·1 | 2·1–11·6 |
| Pb | 5·4 | 1·3 | 0·1 | 2·3–12·4 |

The body shape is extremely variable, especially in large fish. This is more noticeable in Lake Kioga than elsewhere and a graph showing the variation in body depth to length can be seen in fig. 7. It is possible that the deeper-bodied specimens are females but most of the specimens that I have seen had been gutted (see below).

The mouth is sub-terminal and usually in the shape of a narrow horse-shoe. 'Rubber-lipped' forms have been found (e.g. the holotype of *Barbus lobogenys* – see fig. 8). The snout tends to overhang the mouth in fishes of medium size.

*Dorsal fin.* The dorsal fin has four unbranched rays. The last unbranched ray is enlarged into a smooth, straight or slightly curved, well-ossified spine with articulations only at the tip. The dorsal fin spine is negatively allometric ; x̄ = 16·9, s.d. = 3·2, s.e. = 0·2, range = 9·0–30·4 (percentage of the S.L.) for the whole sample (fig. 9). This range is too large to be useful as a diagnostic character but it can be seen from fig. 9 that there are three convenient size ranges of fishes which can be treated separately : 0–170 mm, x̄ = 19·2, s.d. = 3·0, s.e. = 0·3, range = 13·7–30·4 ; 171–250 mm S.L., x̄ = 16·8, s.d. = 1·7, s.e. = 0·2, range = 12·8–20·6 ; above 251 mm S.L., x̄ = 13·4, s.d. = 2·3, s.e. = 0·3, range = 9·9–20·2. It is interesting to note that these three S.L. ranges are the same for *Barbus intermedius* (see p. 68).

The branched rays number 8 (f.30), 9 (f.177) or 10 (f.6). The relative proportions of fishes with 8, 9 or 10 rays does not differ detectably in the three subspecies. The dorsal fin origin is situated in front (rare) or more commonly directly above or just behind the vertical from the origin of the pelvic fins.

The *anal fin* has three simple rays and five branched rays ; the unbranched rays, although thickened, are much more flexible than those in the dorsal fin.

*Pharyngeal bones and teeth.* The pharyngeal teeth almost always number 2.3.5. – 5.3.2. The one exception to this is a specimen from Lake George, S.L. 208 mm B.M. (N.H.) Reg. No. 1971.8.11 : 33–39 which is abnormal and the teeth number 1.1.2.3.5. – 5.3.2.1.

The pharyngeal bones may vary in thickness in fishes of the same size. The variability in the length and thickness of the bones and the teeth is a striking feature of this species and *Barbus intermedius*. Both species have remarkably variable body forms and there appears to be a loose correlation between body depth and the

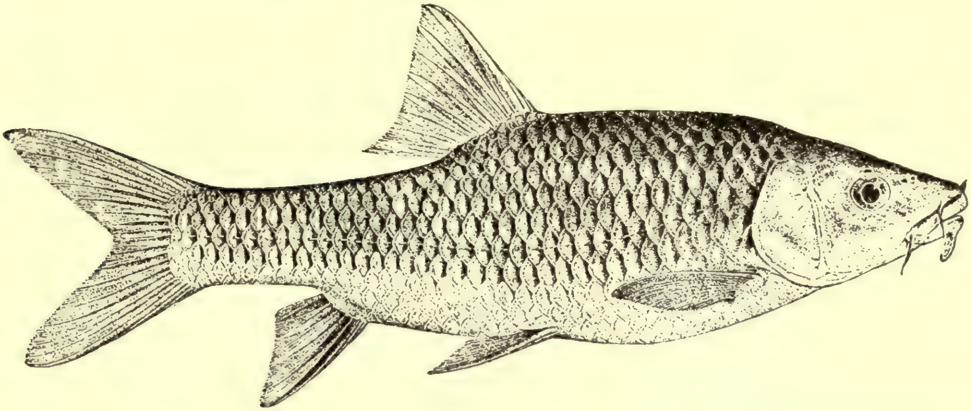


FIG. 8. *Barbus altianalis radcliffii* (Type of *Barbus lobogenys* from Boulenger 1911a).

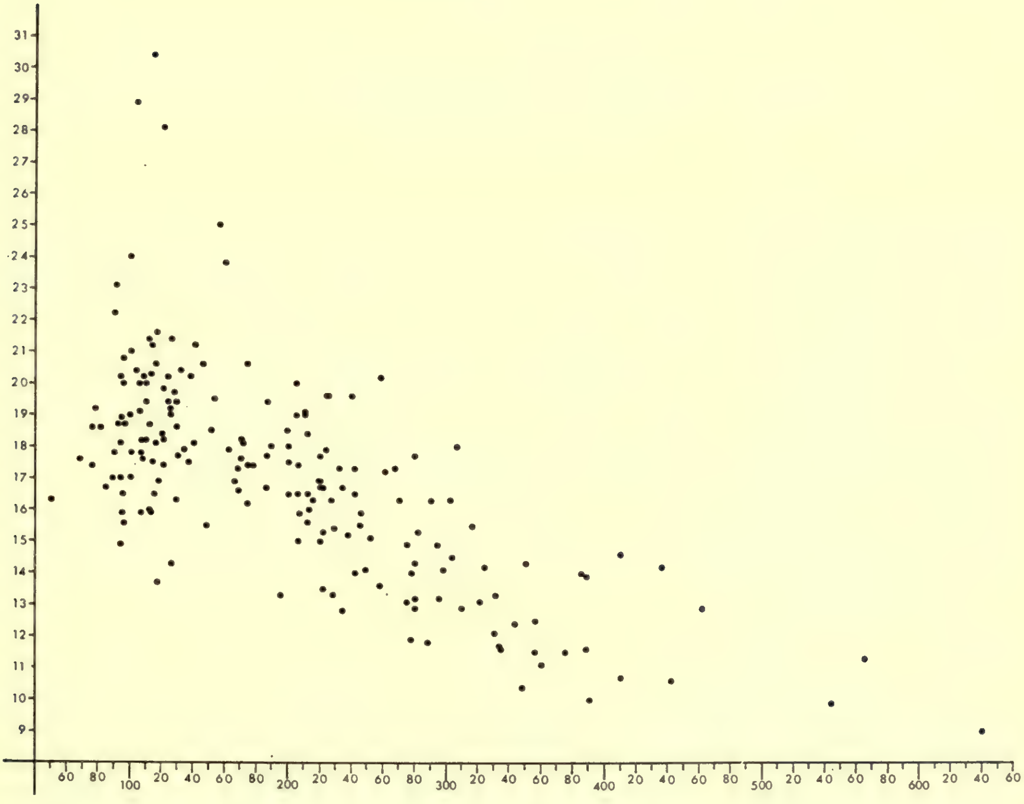


FIG. 9. Scatter diagram of the dorsal spine length as a percentage of the standard length against the standard length for *Barbus altianalis*. (= *Barbus altianalis altianalis*, *Barbus altianalis radcliffii*, *Barbus altianalis eduardianus*).

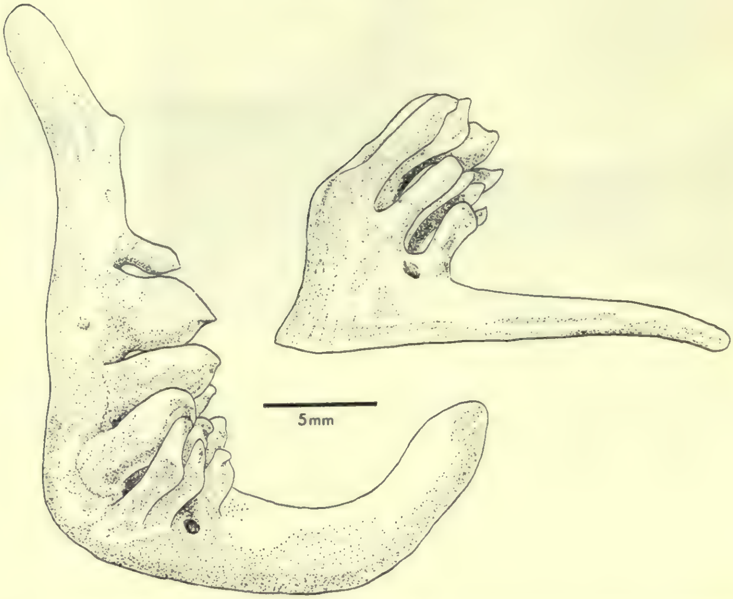


FIG. 10. Dorsal and lateral views of the left pharyngeal bone of the holotype of *Barbus altianalis altianalis*.

tip-to-tip length of the pharyngeal bone. The very deep-bodied specimen of *Barbus altianalis* (i.e. *Barbus obesus*) and the deep-bodied *Barbus intermedius* (i.e. *Barbus surkis*) both have pharyngeal bones that are very much longer and stouter than those of less deep-bodied fishes of the same standard length.

A series of ten fishes from Lake Victoria and ten from Lakes Edward and George were examined to see what relationship was present between the length or depth of the body and the size of the pharyngeal bone. The results from this small trial sample must be used with considerable restraint but using the coefficient of variation technique there are indications that the length of the pharyngeal bone is closely related to the depth of the body. I do not want to pursue this matter any further or in any detail but simply mention the possibility that this correlation is worth further study.

The pharyngeal bone of a long-headed specimen (*Barbus longirostris*) is shown in fig. 12.

Diet presumably must have an effect upon the stoutness of the pharyngeal bones and upon the shape of the teeth. The stomach of the deep-bodied *Barbus intermedius* mentioned above (and p. 69) is full of gastropod mollusc shells, which, if this were its normal diet, could explain the molariform teeth and the stout bone as having been developed as a result of breaking open strong shells. Regrettably, the stomach contents of the deep-bodied *Barbus altianalis* were unidentifiable and there were no traces at all of shells. The extent to which diet affects the pharyngeal teeth

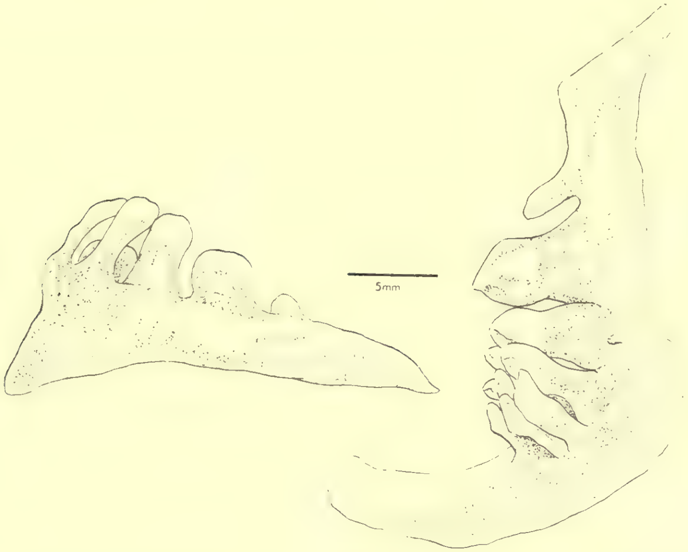


FIG. 11. Dorsal and lateral views of the left pharygeal bone of a specimen of *Barbus altianalis eduardianus*.

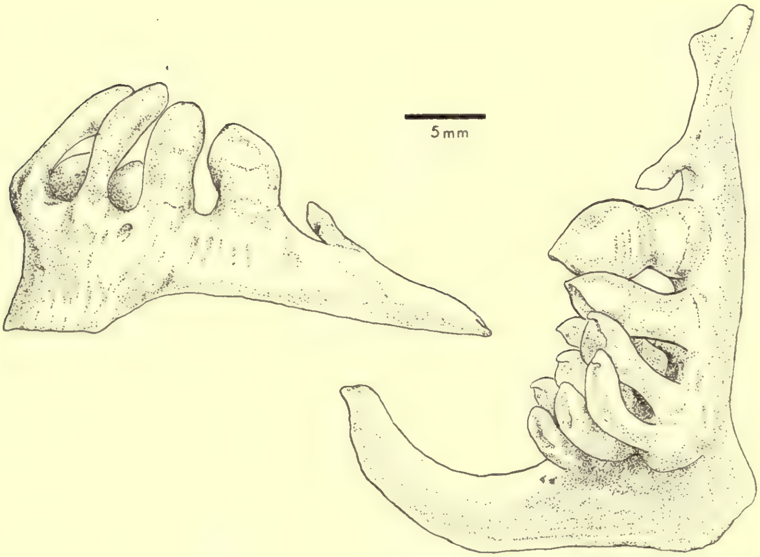


FIG. 12. Dorsal and lateral views of the left pharyngeal bone of *Barbus altianalis radcliffii* (one of the types of *Barbus longirostris* S.L. 410 mm).

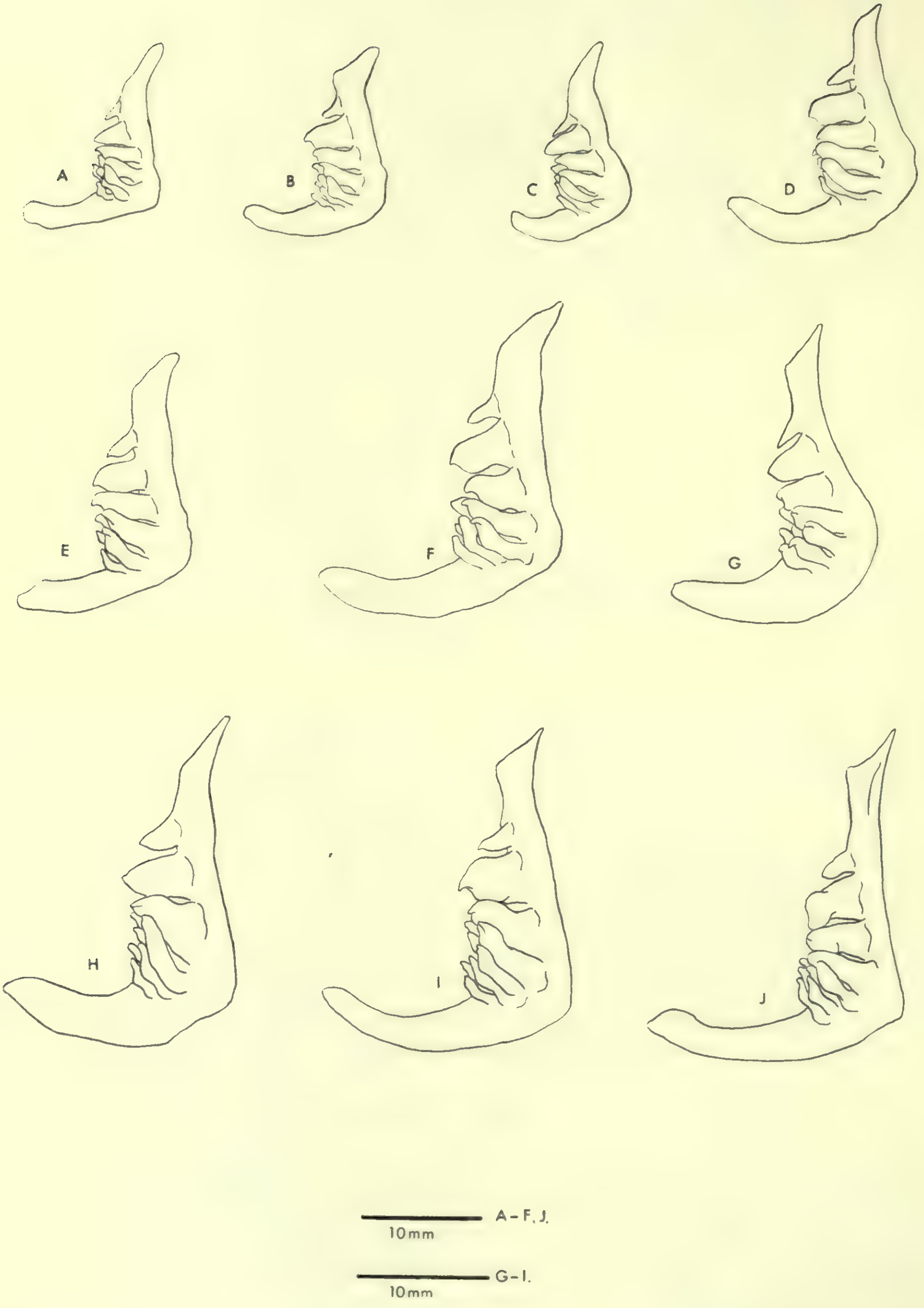

A
B
C
D
E
F
G
H
I
J
A – F, J.
10mm
G – I.
10mm

Fig. 13. A series of pharyngeal bones from specimens of *Barbus altianalis eduardianus*, to show the variation in shape with the growth of the fish. The standard lengths (mm) of the specimens are : A = 90 ; B = 100 ; C = 101 ; D = 125 ; E = 141 ; F = 171 ; G = 205 ; H = 227 ; I = 258 ; J = 330.

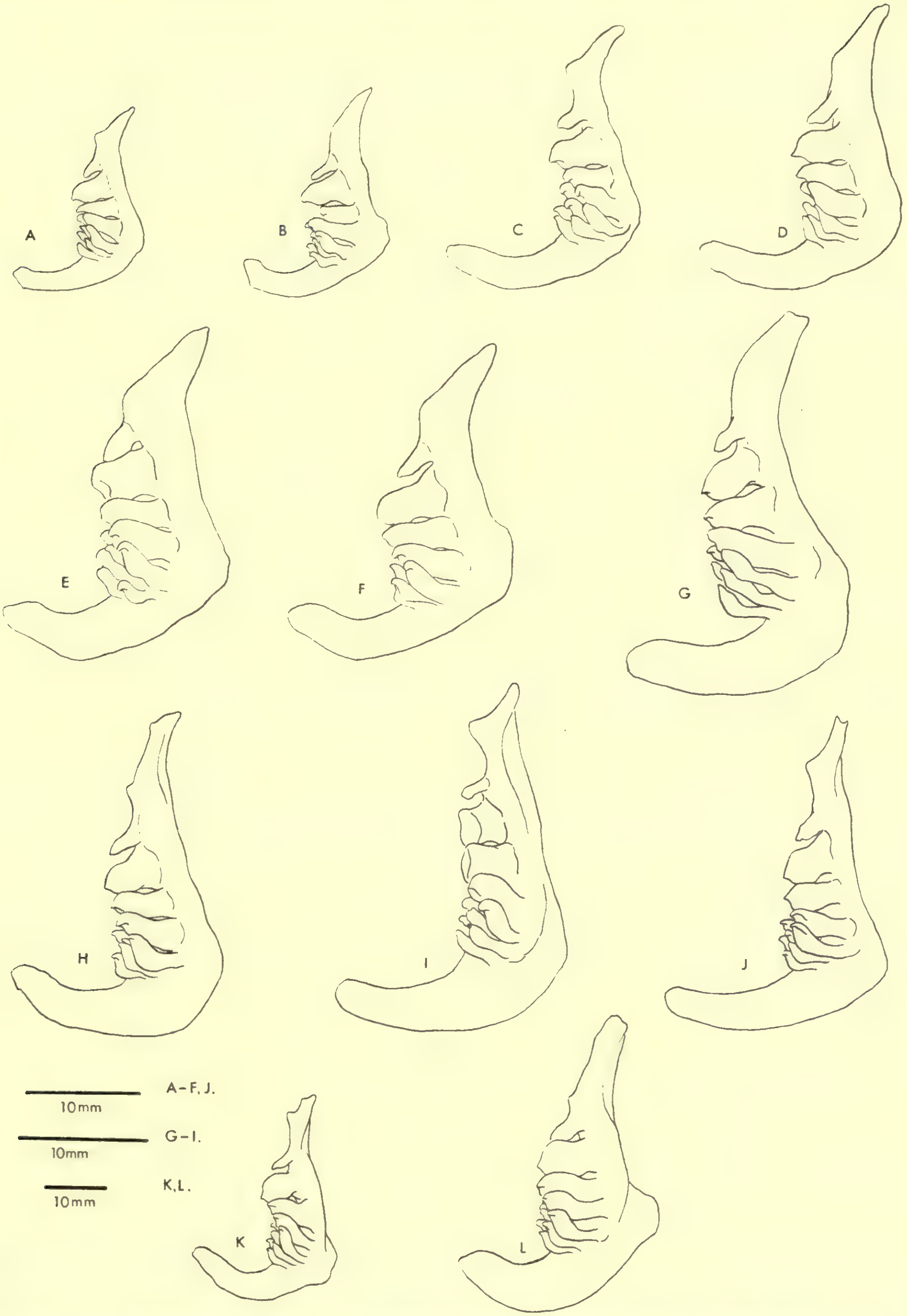


FIG. 14. A series of pharyngeal bones from specimens of *Barbus altianalis radcliffii*. Compare with the series opposite. Standard lengths (mm) of the specimens are: A = 84; B = 102; C = 118; D = 125; E = 145; F = 160; G = 197; H = 228; I = 255; J = 343; K = 410; L = 388. K is from the holotype of *Barbus longirostris*; L is from the holotype of *Barbus obesus*.

in these species cannot be determined at the moment, but further considerations are mentioned on p. 127.

Consistent differences were noted in the pharyngeal bones and teeth of specimens of *Barbus altianalis radcliffii* and *Barbus altianalis eduardianus* of the same size (figs. 13 and 14). The pharyngeal bones of *Barbus altianalis radcliffii* are consistently stouter than those of *Barbus altianalis eduardianus* and the angle of the anterior process is different.

About 15 per cent of the pharyngeal bones examined had a molariform second tooth in the inner row. This phenomenon is as common in Lake Victoria as it is in Lakes Edward and George and is apparently unrelated to size, the molariform tooth being found in a specimen of only 121 mm S.L.

The change in the shape of the pharyngeal bones and teeth with the increase in the size of the fish can be seen in figs. 13 and 14. These should be compared with the series of pharyngeal bones of *Barbus bynni* (fig. 19) – a species with a less variable body form.

Cyprinid pharyngeal bones and teeth have frequently been considered good characters for distinguishing species. The value of this character must now be reconsidered in the light of the observed variability of these characters in *Barbus altianalis*. There are two possible interpretations of the evidence : that either the degree of variation in the pharyngeal bones and teeth has not been fully realized and that it is a dubious character at the species level ; or that certain species only have variable pharyngeal bones and teeth and that for these species the very variation is a good character. Insufficient evidence is available at the moment to expand the arguments for either of the two interpretations.

*Squamation.* The lateral line follows a gentle curve. There are from 28 to 36 scales in the lateral line ; 28 (f.3), 29 (f.6), 30 (f.20), 31 (f.41), 32 (f.57), 33 (f.41), 34 (f.26), 35 (f.9), 36 (f.2) (fig. 59). The number of scales in the lateral line series could not be counted on all the specimens. There are 6·5 (less frequently 5·5, rarely 4·5) scales between the dorsal mid-line and the lateral line and 5·5 (less frequently 6·5, rarely 4·5) scales between the lateral line and the ventral mid-line. The number of scale rows between the lateral line and the origin of the pelvic fin varies, between 2 and 3·5. The number of scales around the caudal peduncle varies from 12 to 14.

*Gill rakers.* There are from 10 to 14 (most frequently 11–13) gill rakers on the lower limb of the first gill arch in all three subspecies.

*Coloration.* Generally the body colour in live fish is from a silvery-grey to a bronzy-green, the scales frequently having dark bases, the operculum slightly bronzy. In fresh specimens from Lake George the pectoral fins are faintly pink with a darker posterior half. The pelvics are grey suffused with pink ; the anal fin membrane is dark at the base. The caudal fin is salmon-pink with a dark posterior edge in specimens of over 100 mm S.L. from Lakes Edward and George. This is a diagnostic character separating the Lake Victoria and the Lakes Edward and George subspecies.

## ***Barbus altianalis altianalis*** Boulenger

A general description of the species is given on p. 12. For comparative purposes morphometric data of the 15 specimens (S.L. 46–410 mm) from Lake Kivu and the Ruzizi river are given below.

| | x̄ | s.d. | s.e. | range |
|---|---|---|---|---|
| L | | | | 49 –410 mm |
| D | 26·9 | 2·3 | 0·6 | 22·6–30·3 |
| H | 25·6 | 1·4 | 0·4 | 23·4–28·0 |
| I | 7·0 | 2·1 | 0·5 | 4·5–10·2 |
| IO | 7·8 | 1·2 | 0·3 | 6·6–10·3 |
| MW | 6·0 | 0·8 | 0·2 | 4·6– 7·7 |
| Pct | 22·0 | 1·1 | 0·3 | 20·2–23·8 |
| CPl | 15·6 | 1·3 | 0·3 | 13·1–17·6 |
| CPd | 11·0 | 0·7 | 0·2 | 10·1–11·4 |
| Snt | 8·5 | 0·9 | 0·2 | 7·3–10·1 |
| Ab | 4·5 | 1·1 | 0·3 | 2·4– 6·6 |
| Pb | 5·9 | 1·2 | 0·3 | 4·6– 8·3 |
| DSp | 16·9 | 2·3 | 0·6 | 13·3–23·1 |

Lateral line count 30 (f.5) ; 31 (f.2) ; 32 (f.3) ; 33 (f.3) ; 34 (f.2).

## ***Barbus altianalis eduardianus*** Boulenger

HOLOTYPE. A fish of 371 mm S.L. B.M. (N.H.) Reg. No. 1906.9.7 : 41 from Lake Edward, Uganda.

DESCRIPTION. The description is based on 130 specimens. A general description is given above. The morphometric data in detail are as follows.

| | x̄ | s.d. | s.e. | range |
|---|---|---|---|---|
| L | | | | 68 –436 mm |
| D | 29·6 | 2·1 | 0·2 | 22·4–37·0 |
| H | 25·8 | 1·6 | 0·1 | 22·5–31·4 |
| I | 8·0 | 1·5 | 0·1 | 4·1–11·5 |
| IO | 8·1 | 0·9 | 0·1 | 6·4–10·8 |
| MW | 6·0 | 0·7 | 0·1 | 4·4– 8·3 |
| Pct | 22·1 | 1·3 | 0·1 | 18·8–25·0 |
| CPl | 17·1 | 1·2 | 0·1 | 14·4–19·7 |
| CPd | 12·4 | 0·9 | 0·1 | 10·1–16·2 |
| Snt | 8·1 | 0·7 | 0·1 | 5·8–10·1 |
| Ab | 4·2 | 0·7 | 0·1 | 2·2– 6·4 |
| Pb | 5·4 | 0·9 | 0·1 | 3·7– 7·3 |
| DSp | 17·5 | 2·4 | 0·2 | 11·7–24·0 |

Lateral line count 28 (f.1), 29 (f.5), 30 (f.9), 31 (f.21), 32 (f.39), 33 (f.22), 34 (f.17) 35 (f.6), 36 (f.2). The lateral line scales could not be counted on all the specimens examined.

It is perhaps unwise to compare this sample with the much smaller sample from Lake Kivu but the general agreement in mean values indicates that the two populations are extremely similar.

### *Barbus altianalis radcliffii* Boulenger

Holotype. A skin of 530 mm S.L. B.M. (N.H.) Reg. No. 1904.5.19 : 13 from Lake Victoria.

Description. The description is based on 68 specimens (S.L. 90–640 mm). A general description is given above. The morphometric data in detail are given below.

| | x̄ | s.d. | s.e. | range |
|---|---|---|---|---|
| L | | | | 90 –640 mm |
| D | 29·6 | 2·7 | 0·3 | 24·0–37·4 |
| H | 26·7 | 1·7 | 0·2 | 23·8–29·8 |
| I | 7·0 | 1·1 | 0·1 | 4·1– 9·3 |
| IO | 9·0 | 1·0 | 0·1 | 7·5–11·2 |
| MW | 6·6 | 1·0 | 0·1 | 4·7– 9·5 |
| Pct | 21·3 | 1·6 | 0·2 | 17·5–24·6 |
| CPl | 16·8 | 1·7 | 0·2 | 13·2–19·8 |
| CPd | 11·7 | 0·9 | 0·1 | 9·5–13·9 |
| Snt | 8·7 | 0·7 | 0·1 | 7·5–10·9 |
| Ab | 4·5 | 1·6 | 0·2 | 2·1–11·6 |
| Pb | 5·3 | 1·9 | 0·2 | 2·3–12·4 |
| DSp | 15·9 | 4·2 | 0·5 | 9·0–30·4 |

Lateral line count 28 (f.2), 29 (f.1), 30 (f.6), 31 (f.18), 32 (f.15), 33 (f.16), 34 (f.7), 35 (f.3).

The mean values for the measurements taken differ little from those of the other two populations. The absence of the red/pink caudal fin in *Barbus altianalis radcliffii* has been mentioned above.

Distribution. *Barbus altianalis* is found in Lake Kivu and the adjacent part of the Ruzizi river, Lake Victoria including the Lake Kioga basin and Lakes Edward and George. Although Lake Victoria and Lakes Edward and George are still connected, migration along the connecting waterways is not easy at the moment. The presence of *Barbus altianalis* in Lake Kivu, which is isolated from Lake Victoria and Lakes Edward and George, and its absence from Lake Albert are facts which must be explained. A certain amount is known about the geological history of the lakes and I have attempted to assemble and correlate recorded events from each lake and to try to explain the distribution of this species.

During the early Pliocene, the region now occupied by Lake Victoria was drained to the west by the upper tributaries of the Congo system (Cooke 1958). This drainage system persisted well into the Pleistocene (Kendall 1969). Stages in the formation of the western rift valley interrupted this flow and the upwarp of the

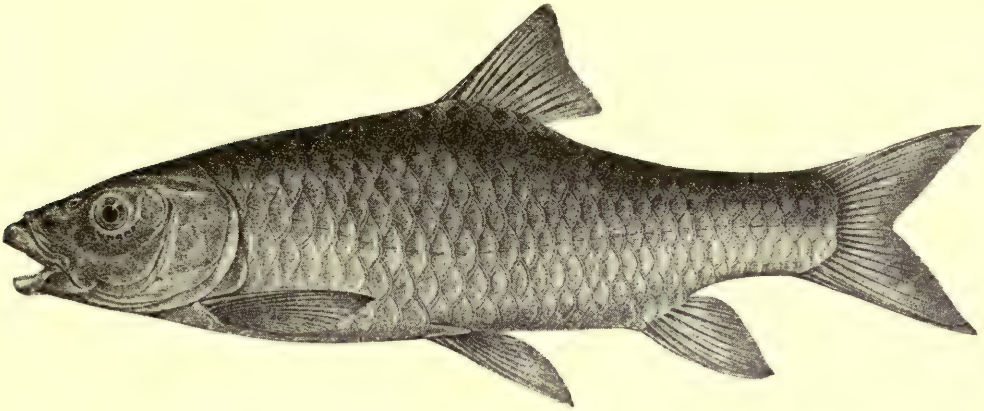


FIG. 15. *Barbus altianalis radcliffii* (the type of *Barbus radcliffii*, from Boulenger 1911a).

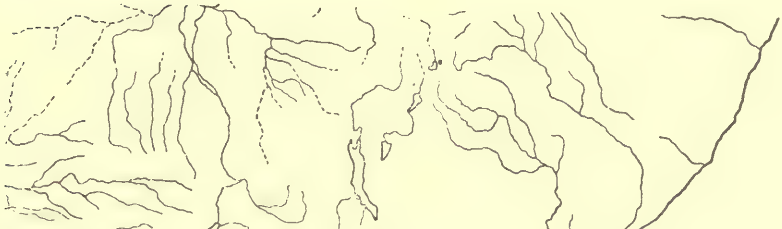


FIG. 16. Map of the distribution of the three subspecies of *Barbus altianalis* : *B. altianalis altianalis* = ●, *B. altianalis eduardianus* = △, *B. altianalis radcliffii* = ■.

eastern shoulder of the rift caused the rivers to reverse their flow and pond-up in the shallow depression between the eastern and western rifts. This led to the formation of the present-day Lake Victoria which Temple (1969) dates from the mid-Pleistocene. Tectonic movements have altered the lake since its original formation.

Lacustrine deposits at Nsongezi in the Kagera valley (to the west of Lake Victoria) are about 35 m above the present lake surface, and some 110 km inland of its western shore. The dates of the Nsongezi deposits are in doubt. Kendall (1969) cites authors who have given dates ranging from 60 000 years B.P. to 10 000 years B.P. Doornkamp and Temple (1966) suggest that continued tectonic warping has caused the eastward drift of the western shore of the lake. Climatic events have probably had an effect as well. Kendall (1969) states that from before 14 500 years B.P. to about 12 000 years B.P. Lake Victoria was a closed basin and the water had a high concentration of salts. From about 12 000 years B.P. to about 10 000 years B.P. the lake had an exit, which could have been to the south, but its locality is by no means certain. Around 10 000 B.P. to about 9500 B.P. the basin became closed again and then drained to the north cutting the Nile gorge. The water level in the lake rose after 12 500 B.P. There followed a period of aridity around 10 000 B.P., the water level fell and the outlet was lost. A wetter climate ensued, the lake level rose, overflowed to the north and established the Nile outflow. It is difficult to correlate these events because tectonic movements, climatic changes and the rate of discharge from the lake have all had an effect upon the lake size, level and position. The date of cessation of the tectonic movements is not known with certainty but there are three horizontal raised beaches 3, 12 and 18 m above the lake level which were presumably formed after earth movements had ceased. The most recent of these has been dated at 3720 years B.P. (Stuvier *et alii* 1960). Kendall (1969) argues that they all must be post 12 500 B.P. which may well indicate that tectonicity had stopped by that time. The different beach levels are possibly related to stages in the erosion of the Nile gorge.

Much less is known about Lake Kivu and very little absolute dating has been done. Lake Kivu resulted from the effects of eruptions of the Mufumbiro (or Bufumbiro) volcanoes (to the north of the present lake) when lava flows dammed the rift valley. Prior to this unknown date the drainage in this part of the rift is usually thought to have been northwards, but there may have been a proto-Lake Kivu. Cahen (1954) describes the origin of Lake Kivu as the result of the landscape changes which affected a network of rivers flowing S.W. to N.E. which curved northwards and ponded-up to form the lake. This direction of flow is possibly not compatible with the ideas of Cooke (1958) who describes the drainage as roughly E. to W. but this may have been due to local topographical features. The lake later rose in height and spilled over southwards to drain into Lake Tanganyika cutting the Ruzizi gorge. Kendall (1969) noted that *circa* 12 450 B.P. Lake Kivu was 100 m higher than its present level This date was established by radio-carbon dating on mollusc shells on a raised beach. Possibly this immediately pre-dates the formation of the Ruzizi river.

The critical date of the eruption of the Mufumbiro volcanoes is unknown. Cahen (1954) states that it was before the end of the alleged Kamasien ; Bishop (pers.

comm.) dates the eruptions as upper Pleistocene and Fryer (1968) suggests a date of about 100 000 years B.P. Lake Kivu has been connected to Lake Tanganyika for a minimum period of 12 000 years and although *Barbus altianalis* is found in the Ruzizi river at the Lake Kivu end it has not been recorded from Lake Tanganyika (Poll 1953; Marlier 1953). *Barilius moorii* has made the journey in the other direction (Poll 1950). Why only *Barilius moorii* has been able to ascend the Ruzizi river is a question that I am unable to answer. It may be that the ascent of the river is easier for some species than the descent is for others. There are also rapids on the Ruzizi river which must limit the amount of faunal interchange. All that one can say at the moment is that for at least the last 12 000 years only one species of fish is known to have successfully navigated the Ruzizi river.

A lake occupying the site on the floor of the western rift valley now occupied by Lakes Edward and George began to form at the time of the uplift of the rift wall. This corresponds with fig. 2B in Doornkamp and Temple (1966), and Bishop (1971) dates it as late Pliocene. Rivers drained onto the floor of the rift and a lake resulted. There was probably more than one lake, for the extensive Kaiso beds (later Pliocene) are lacustrine as, largely, are the overlying Semliki deposits (mid- to later Pleistocene). The full extent of the 'Kaiso' and 'Semliki' lakes both in time and area is not completely known. The Kaiso beds are up to 8000 feet thick (Brown 1956) and represent possibly three million years of comparative stability. Bishop (1969) noted that the Kaiso and Semliki deposits are separated in time by renewed movement of the rift valley boundary faults. The Semliki beds are found north of Lake Albert indicating a very large area for the 'Semliki' lake. The uppermost Semliki beds are later Pleistocene with an age in excess of 10 000 years B.P.

At the end of the Semliki period soil formation occurred and about 8000 years to 10 000 years B.P. the Katwe volcanoes ceased erupting and the present forms of Lakes Edward, George and the Kazinga channel became defined. The Kazinga channel runs through the Katwe lavas, but probably dates from the time that soil formation occurred, i.e. the post-Semliki period. The form of the channel was little altered by the volcanic activity (Bishop 1969 : 45).

The Ishango beds, which were deposited during the active phase of the Katwe volcanoes (8000 years to 10 000 years B.P., Bishop, *op. cit.*), have yielded fossil *Barbus* species remains at Ishango on the Semliki river exit from Lake Edward (Greenwood 1959). From Site IX in Makalian strata, fossils comparable with *Barbus bynni* and *Barbus altianalis*, then dated Mesolithic or Holocene, were described by Greenwood (*op. cit.*). Site VI at Ishango, in the upper Semliki beds (Katanda formation), dated mid-Pleistocene [but older than the Nsongezi deposits (Bishop 1969)], yielded unidentifiable *Barbus* species fragments, the oldest known from this area.

Today the fish fauna of Lake Edward is different from that of Lake Albert, the former lacking species present in the latter. The Semliki river connects the two lakes; probably the rapids and possibly the cooler streams flowing down from the Ruwenzori mountains (Fryer 1968) prevent any faunal interchange. The fauna of Lake Edward is poor, lacking representatives of some widespread African fish families, e.g. Polypteridae, Characidae, Mochokidae, Centropomidae and Mastacembelidae, as well as some specifically Nilotic species present in Lake Albert, e.g.

*Lates niloticus* and *Barbus bynni*. This situation has been described in detail by Greenwood (1959).

Some of the species now absent from Lake Edward have been found fossilized in the Ishango beds. Kendall (1969) states that the major fish extinctions probably occurred within the last 18 000 years. *Polypterus, Lates, Synodontis* and *Barbus* cf. *bynni* were present some 8000–10 000 years ago. Characins disappeared much earlier in the fossil record, the latest known fossil *Hydrocynus* occurring in the Kaiso beds (probably lower Pleistocene). Certainly, at the time the Ishango beds were deposited, the fish fauna of Lake Edward was closer to that now in Lake Albert than it is today.

The Ishango beds lie on, and are also covered by, volcanic rocks (Bishop 1969). So, it would seem very possible that some species were killed by the outpourings of the Katwe eruptions. It is less likely that a drying up of the lake caused the extinctions because there is no evidence for such an event and Kendall (1969) suggests that in the Lake Victoria basin the period from 9500 B.P. to 6500 B.P. was marked by high water levels and the levels fell only slightly from 6500 B.P. onwards.

It is uncertain whether Lake Edward became completely denuded of fish life at the end of the Ishango period. If it did then the lake has been recolonized ; if it did not, then some species must have escaped, or must have remained unaffected by the eruptions. Dr P. H. Greenwood (pers. comm.) reports having seen fish behaving normally within a hundred metres of a lava stream entering Lake Kivu, this suggests that perhaps an increase of toxic products in the water is more lethal than the heating effect of the lava. Possible means by which various species could have survived are discussed by Greenwood (1959). They include migration into feeder streams and different degrees of resistance to toxicity and low oxygen concentrations.

If there was an invasion from Lake Victoria it must have occurred since 8000 B.P. (the date of cessations of the Katwe volcanoes). However, since that time there is no evidence that Lake Victoria has been subjected to any great earth movements (see above) and it had already gained its outlet via the Nile gorge. This would limit any rises in water level to about 18 m above the present level. The watershed between Lakes Edward and George and Lake Victoria is extremely low. Now the Katonga river is blocked by Papyrus swamp but a few metres rise in water level might possibly enable fishes to travel from Lake Victoria into Lakes George and Edward. The fact that no, e.g. *Haplochromis*, fossils have been found in the Ishango beds does not necessarily mean that they have invaded the lake in post-Ishango times. The fossils could yet await discovery. Present studies (Dr P. H. Greenwood, pers. comm.) have suggested that Lake Edward *Haplochromis* species are not as closely related to particular Lake Victoria *Haplochromis* species as had been thought, which possibly militates against the idea of an invasion from Lake Victoria.

It seems much more likely that the fauna of Lakes Edward and George and Lake Kivu was originally widespread in the upper reaches of the old Congo system and became isolated in the present lake basins as a result of tectonicity. It would be very difficult to explain satisfactorily how *Barbus altianalis* could have migrated into Lake Kivu from either Lake Edward or Lake Victoria. At the time of the highest known level reached by Lake Kivu, 12 450 B.P., Lake Victoria was not at its highest. However, it must be noted that Lake Victoria possibly had an outlet (see above) whose direction is unknown. The general topography of the Lake Kivu basin makes invasion from the east or north extremely unlikely.

If, as judged by their breeding habits (Whitehead 1964), *Barbus* species are fundamentally fluviatile fishes, then it is more likely that *Barbus altianalis* originally lived in the upper reaches of the Congo system in the area now occupied by Lakes Kivu, Edward, George and Victoria. Since the suggested modifications in its range the *Barbus altianalis* populations have undergone no significant morphological changes but the colour difference in the caudal fin is noted above.

DIAGNOSIS AND AFFINITIES. *Barbus altianalis* has three recognized subspecies which are meristically and morphometrically very similar. The pink caudal fin in Lakes Edward and George subspecies *Barbus altianalis eduardinanus* separates this subspecies from *Barbus altianalis radcliffii* of Lake Victoria. No information is available on the live colour of *Barbus altianalis altianalis* from Lake Kivu.

*Barbus altianalis* is, in gross morphology, similar to *Barbus intermedius* but the two species are separable on the modal lateral line count (see fig. 59), 26–34 (most frequently 28–32 ; mode 29) in *Barbus intermedius* ; 28–35 (most frequently 30–34, mode 32) in *Barbus altianalis*. The last unbranched ray in the dorsal fin is slightly shorter in *Barbus altianalis* (9·0–30·4 per cent S.L., $\bar{x} = 16·9$) than in *Barbus intermedius* (6·9–33·9, $\bar{x} = 20·1$). The anterior and posterior barbels are shorter in *Barbus altianalis* (Ab 2·1–11·6 per cent S.L., $\bar{x} = 4·3$ ; Pb 2·3–12·4, $\bar{x} = 5·4$) than in *Barbus intermedius* (Ab 1·8–11·1, $\bar{x} = 5·8$ ; Pb 1·9–12·1, $\bar{x} = 6·9$).

For a comparison of *Barbus acuticeps* and *Barbus altianalis* see under the former species.

*Barbus ruasae*, from Rwanda, is somewhat similar in appearance to *Barbus altianalis* but can be distinguished easily from it by the fewer lateral line scales (25–26 against 28–35).

*Barbus altianalis* is considered here to belong to the *Barbus intermedius* group.

## ***Barbus bynni*** (Forsskål) 1775

*Cyprinus bynni* Forsskål, 1775, *Descrip. Anim.* : 71.
*Barbus bynni* : Blgr., 1911, *Cat. Afr. Fish* **2** : 26, fig. 8 (includes a full bibliography up to this date).
*Barbus ruspolii* Vinciguerra, 1896, *Annali Mus. civ. Stor. natn. Giacomo Doria* (2) **17** : 29.
*Barbus meneliki* Pellegrin, 1905, *Bull. Mus. Hist. nat. Paris* **16** : 293
*Barbus bynni rudolfianus* Worthington, 1932, *J. Linn. Soc.* (Zool.) **38** : 132.

NOTES ON THE SYNONYMY. The type specimen of *Barbus bynni* is no longer extant (Klausewitz & Nielsen 1965) and a neotype has been selected (see below). The holotype of *Barbus ruspolii* is in a very poor state and has not been seen by me, but other specimens referred by Vinciguerra to *Barbus ruspolii* have been examined. The holotype and unique specimen of *Barbus meneliki* in the Paris Museum has been studied.

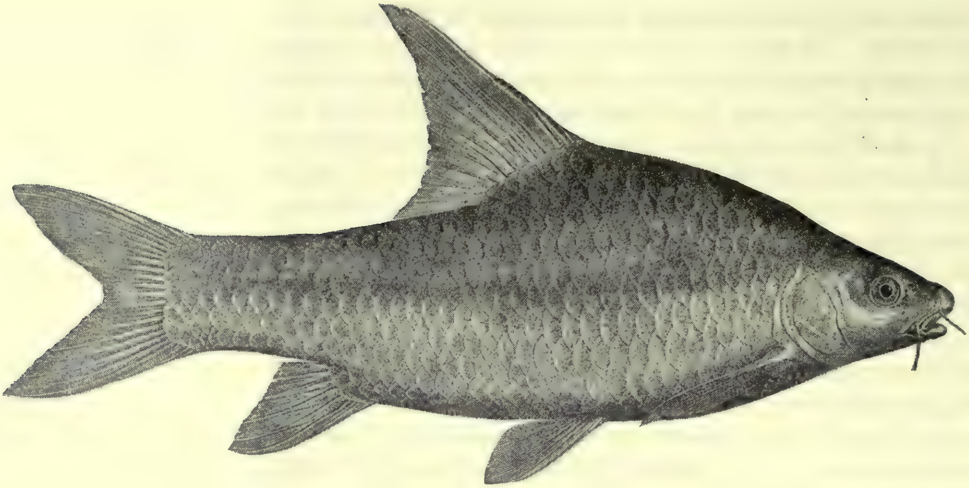


FIG. 17. *Barbus bynni* (from Boulenger 1911a).

The similarity of *Barbus bynni* to *Barbus ruspolii* was noted by Boulenger (1907) and by Worthington (1932a). The latter author was also of the opinion that *Barbus meneliki* from Lake Rudolf was close to his *Barbus bynni rudolfianus*. *Barbus meneliki* is very similar in many respects to *Barbus bynni rudolfianus* from the same lake. The greatest difference is the presence of 29/30 lateral line scales in the former against 34 or 35 in the latter. *Barbus bynni* from Lake Albert have a lateral line range of 28 to 35 scales. *Barbus meneliki* is based on the holotype and unique specimen so either it is an extremely rare fish in the lake or it is a member of Lake Rudolf's *Barbus bynni* population with fewer scales than usual. As I have seen only five *Barbus bynni* specimens from Lake Rudolf the latter suggestion seems the more likely especially when the information is compared with the lateral line scale count range in Lake Albert fish. The mouth of *Barbus meneliki* has a horny covering on the lower jaw, although this has not been seen in other Lake Rudolf specimens of *Barbus bynni*, it is not an unusual phenomenon in *Barbus* species (Groenewald 1958). In all other respects (e.g. dorsal spine length, caudal peduncle shape and scale striations) *Barbus meneliki* and *Barbus ruspolii* both closely resemble *Barbus bynni* hence I consider them conspecific. Boulenger (1907) remarked that little work had been done on the morphometric variation in *Barbus bynni*, both within one population and between isolated populations. What little I have been able to do is detailed below.

NEOTYPE. Klausewitz and Nielsen (1965) listed *Cyprinus bynni* as being 'no longer in existence from Forsskål's original collection'. I have also tried but without success to trace this specimen and must agree with Klausewitz and Nielsen that the specimen is, at least, lost. Therefore I have selected as a neotype B.M. (N.H.) specimen No. 1907.12.2 : 1230, a fish of 152 mm S.L. collected from the Nile at Asswan. Forsskål did not state the size of his specimen nor its exact locality, so I have selected this fish as it appears to be a modal representative of the fishes from the lower Nile.

DESCRIPTION. The description is based on a total of 63 fish ; 36 from the lower and White Niles ; ten from Lake Albert ; five from the Blue Nile ; seven from Lake Abaya and five from Lake Rudolf. A further specimen doubtfully from the Webi Shebeli will be treated separately.

The body is shaped like an elongate rhomboid, the dorsal profile rises sharply and evenly from the snout to the occiput and then more steeply to the origin of the dorsal fin. The profile of the belly slopes down to a point in front of the ventral fins. The body is compressed, more so than in most other species under consideration. The compressed caudal peduncle is short and deep and is quite characteristic for *Barbus bynni*.

The scales bear sinuous longitudinal striae.

The most distinctive features are the massive dorsal spine and the caudal peduncle. At least one specimen (a fish from the lower Nile) shows the development of 'rubber lips'.

The following tables show the range, mean, standard deviation and standard error of the measurements taken for the five populations.

Range of standard lengths of the populations examined (in mm)

| | | No. of specimens |
|---|---|---|
| Nile | 59–351 | 36 |
| Lake Albert | 136–349 | 10 |
| Blue Nile | 95–246 | 5 |
| Lake Abaya | 236–329 | 7 |
| Lake Rudolf | 196–233 | 5 |
| Total | 59–351 | 63 |

Body depth (this and all subsequent data are expressed as percentages of the S.L.)

| Locality | n | x̄ | s.d. | s.e. | range |
|---|---|---|---|---|---|
| Nile | 36 | 32·9 | 2·5 | 0·4 | 26·0–37·7 |
| Lake Albert | 10 | 34·6 | 2·7 | 0·8 | 31·0–39·6 |
| Blue Nile | 5 | 34·3 | 1·9 | 0·8 | 31·6–36·2 |
| Lake Abaya | 7 | 35·0 | 2·5 | 1·0 | 31·4–37·7 |
| Lake Rudolf | 5 | 33·6 | 2·3 | 1·0 | 30·0–36·0 |
| Total | 63 | 33·6 | 2·5 | 0·3 | 26·0–39·6 |

Head length

| Locality | n | x̄ | s.d. | s.e. | range |
|---|---|---|---|---|---|
| Nile | 36 | 24·0 | 1·7 | 0·3 | 21·4–30·6 |
| Lake Albert | 10 | 24·7 | 1·0 | 0·3 | 23·6–26·9 |
| Blue Nile | 5 | 25·3 | 0·7 | 0·3 | 24·4–26·3 |
| Lake Abaya | 7 | 24·9 | 1·3 | 0·5 | 23·1–26·2 |
| Lake Rudolf | 5 | 24·3 | 0·6 | 0·3 | 24·0–25·3 |
| Total | 63 | 24·4 | 1·5 | 0·8 | 21·4–30·6 |

### Eye diameter

| Locality | n | x̄ | s.d. | s.e. | range |
|---|---|---|---|---|---|
| Nile | 36 | 7·0 | 1·3 | 0·2 | 4·3–10·2 |
| Lake Albert | 10 | 6·7 | 1·1 | 0·4 | 5·7– 8·3 |
| Blue Nile | 5 | 7·2 | 0·7 | 0·3 | 6·9– 8·4 |
| Lake Abaya | 7 | 5·7 | 0·5 | 0·2 | 5·3– 6·3 |
| Lake Rudolf | 4 | 7·0 | 0·3 | 0·2 | 5·5– 7·3 |
| Total | 62 | 7·0 | 1·3 | 0·2 | 4·3–10·2 |

### Interorbital width

| Locality | n | x̄ | s.d. | s.e. | range |
|---|---|---|---|---|---|
| Nile | 36 | 8·1 | 0·8 | 0·1 | 7·0–11·7 |
| Lake Albert | 10 | 8·6 | 1·0 | 0·3 | 7·0–10·5 |
| Blue Nile | 5 | 8·2 | 0·8 | 0·4 | 7·2– 8·7 |
| Lake Abaya | 7 | 8·4 | 0·4 | 0·1 | 8·1– 8·8 |
| Lake Rudolf | 4 | 8·0 | 0·3 | 0·1 | 7·7– 8·3 |
| Total | 62 | 8·2 | 0·8 | 0·1 | 7·0–11·7 |

### Mouth width

| Locality | n | x̄ | s.d. | s.e. | range |
|---|---|---|---|---|---|
| Nile | 36 | 5·5 | 0·7 | 0·1 | 4·2–7·3 |
| Lake Albert | 10 | 6·0 | 0·6 | 0·2 | 4·9–6·9 |
| Blue Nile | 5 | 5·9 | 0·4 | 0·2 | 5·4–6·5 |
| Lake Abaya | 7 | 6·2 | 0·7 | 0·3 | 5·4–6·9 |
| Lake Rudolf | 4 | 5·0 | 0·7 | 0·3 | 4·3–5·8 |
| Total | 62 | 5·7 | 0·7 | 0·1 | 4·2–7·3 |

### Pectoral fin length

| Locality | n | x̄ | s.d. | s.e. | range |
|---|---|---|---|---|---|
| Nile | 36 | 21·3 | 1·3 | 0·2 | 18·4–24·3 |
| Lake Albert | 10 | 21·5 | 1·0 | 0·3 | 19·0–22·6 |
| Blue Nile | 5 | 24·5 | 1·3 | 0·6 | 23·1–25·8 |
| Lake Abaya | 7 | 24·2 | 1·9 | 0·7 | 21·6–26·4 |
| Lake Rudolf | 5 | 21·0 | 1·2 | 0·5 | 19·6–22·5 |
| Total | 63 | 21·9 | 1·8 | 0·2 | 18·4–26·4 |

### Caudal peduncle length

| Locality | n | x̄ | s.d. | s.e. | range |
|---|---|---|---|---|---|
| Nile | 36 | 17·0 | 1·5 | 0·2 | 13·5–21·1 |
| Lake Albert | 10 | 16·4 | 1·5 | 0·5 | 14·7–19·7 |
| Blue Nile | 5 | 16·2 | 0·7 | 0·3 | 15·4–17·0 |
| Lake Abaya | 7 | 17·1 | 1·8 | 0·7 | 15·5–20·6 |
| Lake Rudolf | 4 | 17·1 | 0·6 | 0·3 | 16·6–17·5 |
| Total | 62 | 16·9 | 1·4 | 0·2 | 13·5–21·1 |

Caudal peduncle depth

| Locality | n | x̄ | s.d. | s.e. | range |
|---|---|---|---|---|---|
| Nile | 36 | 13·8 | 1·6 | 0·3 | 11·7–19·4 |
| Lake Albert | 10 | 14·3 | 0·9 | 0·3 | 13·1–15·4 |
| Blue Nile | 5 | 13·5 | 0·5 | 0·2 | 12·6–18·0 |
| Lake Abaya | 7 | 13·6 | 0·7 | 0·3 | 12·6–14·6 |
| Lake Rudolf | 5 | 13·4 | 0·1 | 0·1 | 13·0–13·9 |
| Total | 63 | 13·8 | 1·3 | 0·2 | 11·7–19·4 |

Snout length

| Locality | n | x̄ | s.d. | s.e. | range |
|---|---|---|---|---|---|
| Nile | 36 | 7·7 | 0·7 | 0·1 | 6·7–10·5 |
| Lake Albert | 10 | 7·8 | 0·9 | 0·3 | 5·7– 9·2 |
| Blue Nile | 5 | 8·1 | 0·3 | 0·1 | 7·7– 8·4 |
| Lake Abaya | 7 | 8·2 | 0·4 | 0·1 | 7·6– 8·8 |
| Lake Rudolf | 5 | 8·0 | 0·3 | 0·1 | 7·5– 8·3 |
| Total | 63 | 7·8 | 0·7 | 0·1 | 5·7–10·5 |

Anterior barbel

| Locality | n | x̄ | s.d. | s.e. | range |
|---|---|---|---|---|---|
| Nile | 34 | 4·6 | 1·4 | 0·2 | 2·3–6·0 |
| Lake Albert | 10 | 2·4 | 0·8 | 0·1 | 1·2–4·6 |
| Blue Nile | 5 | 6·3 | 1·1 | 0·4 | 5·7–6·9 |
| Lake Abaya | 7 | 5·7 | 0·5 | 0·2 | 4·6–6·1 |
| Lake Rudolf | 5 | 2·5 | 0·5 | 0·2 | 2·1–2·9 |
| Total | 61 | 4·4 | 1·4 | 0·1 | 1·2–6·9 |

Posterior barbel

| Locality | n | x̄ | s.d. | s.e. | range |
|---|---|---|---|---|---|
| Nile | 34 | 5·8 | 1·0 | 0·1 | 4·2–8·4 |
| Lake Albert | 10 | 4·2 | 1·1 | 0·3 | 3·2–6·9 |
| Blue Nile | 5 | 6·5 | 0·5 | 0·2 | 6·1–7·4 |
| Lake Abaya | 7 | 6·1 | 0·5 | 0·1 | 5·7–6·8 |
| Lake Rudolf | 5 | 4·0 | 0·2 | 0·1 | 3·9–4·3 |
| Total | 61 | 5·5 | 1·2 | 0·1 | 3·2–8·4 |

Of particular note is the ratio of the caudal peduncle length to its depth, which has a mean value of 1·23. Only one specimen that I examined had a ratio greater than 1·40.

The figures presented here show that the barbels are shorter in fishes from Lakes Rudolf and Albert than they are in the other localities but the significance, considering the inequality of the samples, is low.

On the basis of the evidence from morphometrics any attempt to maintain or establish sub-specific categories is rather unsound. Any such attempts must be supported by evidence not available to the museum worker.

*Squamation.* The scales of *Barbus bynni* have slightly irregular parallel striae (fig. 93). There are from 28 to 37 scales in the lateral line series. The range and the mean (to the nearest whole number) of scales on the lateral lines from the different localities are given below.

| Locality | x̄ | range |
|---|---|---|
| Nile | 33 | 31–37 |
| Lake Albert | 32 | 28–35 |
| Blue Nile | 31 | 28–33 |
| Lake Abaya | 32 | 31–34 |
| Lake Rudolf | 33 | 28–35 |
| Total | 33 | 28–37 |

Six and a half (less frequently 5·5) scales are present between the dorsal mid-line and the lateral line. Five and a half (rarely 6·5 or 4·5) scales are present between the lateral line and the ventral mid-line. The number of scales between the lateral line and the base of the ventral fin varies from 2 to 4·5; then, 2 (f.1), 2·5 (f.20), 3 (f.20), 3·5 (f.14), 4 (f.7), 4·5 (f.1). There is no apparent correlation between locality and this count. There are from 12 to 16 scales around the caudal peduncle; 12 (f.8), 13 (f.22), 14 (f.17), 15 (f.7), 16 (f.7). The fish from the Blue Nile had 12 scales around the caudal peduncle whilst those from Lake Rudolf had 16. Two of the Lake Albert fish also had 16. The samples are too small though to use such a variable character to establish a population taxonomically.

*Dorsal fin.* The dorsal fin has 8 (f.1), 9 (f.59), 10 (f.3) branched rays, the fourth unbranched ray is ossified into a straight, massive spine.

*Dorsal spine.*

|  | n | x̄ | s.d. | s.e. | range |
|---|---|---|---|---|---|
| White Nile | 36 | 29·3 | 3·4 | 0·6 | 23·7–38·4 |
| Lake Albert | 10 | 30·9 | 2·5 | 0·8 | 24·9–35·2 |
| Blue Nile | 5 | 36·4 | 5·0 | 2·2 | 29·5–40·0 |
| Lake Abaya | 7 | 35·3 | 3·9 | 1·5 | 28·8–39·3 |
| Lake Rudolf | 5 | 34·1 | 5·2 | 2·3 | 30·0–43·0 |
| Total | 63 | 31·1 | 4·3 | 0·6 | 23·7–43·0 |

The *anal fin* has three unbranched rays and five branched rays.

*Pharyngeal bones and teeth.* The pharyngeal teeth (fig. 18) number five in the inner row. The first tooth is small and angled towards the second tooth. This tooth becomes mammilliform with increasing size but is almost always higher than it is long (cf. *Barbus gananensis*). Small concavities develop on the posterior face of the crown on teeth 3, 4 and 5. These three teeth become successively more slender and the fifth tooth becomes markedly hooked in large fishes. The three teeth of the second row and the two teeth of the third row resemble the last tooth in the inner row in shape. A series of pharyngeal bones (fig. 19) shows the variation in shape with the growth of the fish.

*Gill rakers.* There are 12 to 16 gill rakers on the lower limb of the first gill arch.

*Coloration.* Described by Boulenger (1911a) as yellowish or silvery, grey or olive on the back, fins yellow or orange, anal and caudal pink or red, ends of dorsal and

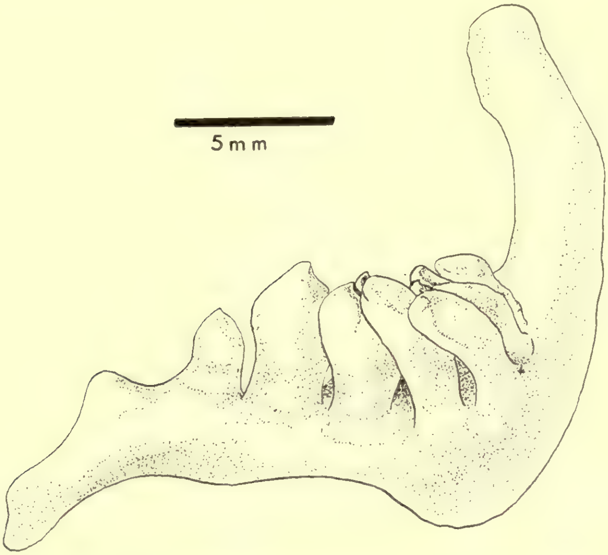


FIG. 18. Dorsal view of the left pharyngeal of *B. bynni* of 280 mm S.L.

caudal rays sometimes blackish. Amirthalingam (1965), describing *Barbus bynni* from the Sudan, states that the colour is very variable, but in live fish of about 250 mm is frequently as follows: body silvery, dark above and light below; all fins with deep-orange streaks; dorsal and caudal fins edged with black; anal, pelvic and pectoral fins edged with white.

DISTRIBUTION. Specimens from Lake Abaya, Lake Rudolf and Lake Albert have been examined. Sandon (1950) states that *Barbus bynni* is common in the Blue Nile and I have seen specimens from the Metti and Gudar rivers and from Rosaires. Sandon (*op. cit.*) also refers to the widespread distribution of *Barbus bynni* throughout the White Nile, although the B.M. (N.H.) collections have no specimens from between Khartoum and Lake Albert. This species is common throughout the lower Nile.

Specimens nos. 92–101 listed by Boulenger (1911a : 28) from Lake Baringo are not referable to this species, but belong to *Barbus intermedius*.

Peel (1900 : 336) records *Barbus byrni* (sic) from the Webi Shebeli in Somaliland. Donaldson-Smith (1897) collected three specimens of a *Barbus* species identified as *Barbus bynni* by Günther (1896); the two small specimens from Stony Brook, the Errer river (Webi Shebeli system) (Academy of Natural Sciences Philadelphia, Nos. 14541, 14542), are not *Barbus bynni* but the large specimen is. The two small fishes are mentioned with details of the locality in Donaldson-Smith's account of his expedition but there is no mention of the large fish. Günther (1896) gives its locality as the Shebeli river. This specimen is now in the collection of the Philadelphia Academy of Natural Sciences No. 16710, where the locality Thebeti, East Africa, has been given to it. Thebeti could well be a mis-reading of Shebeli, for the

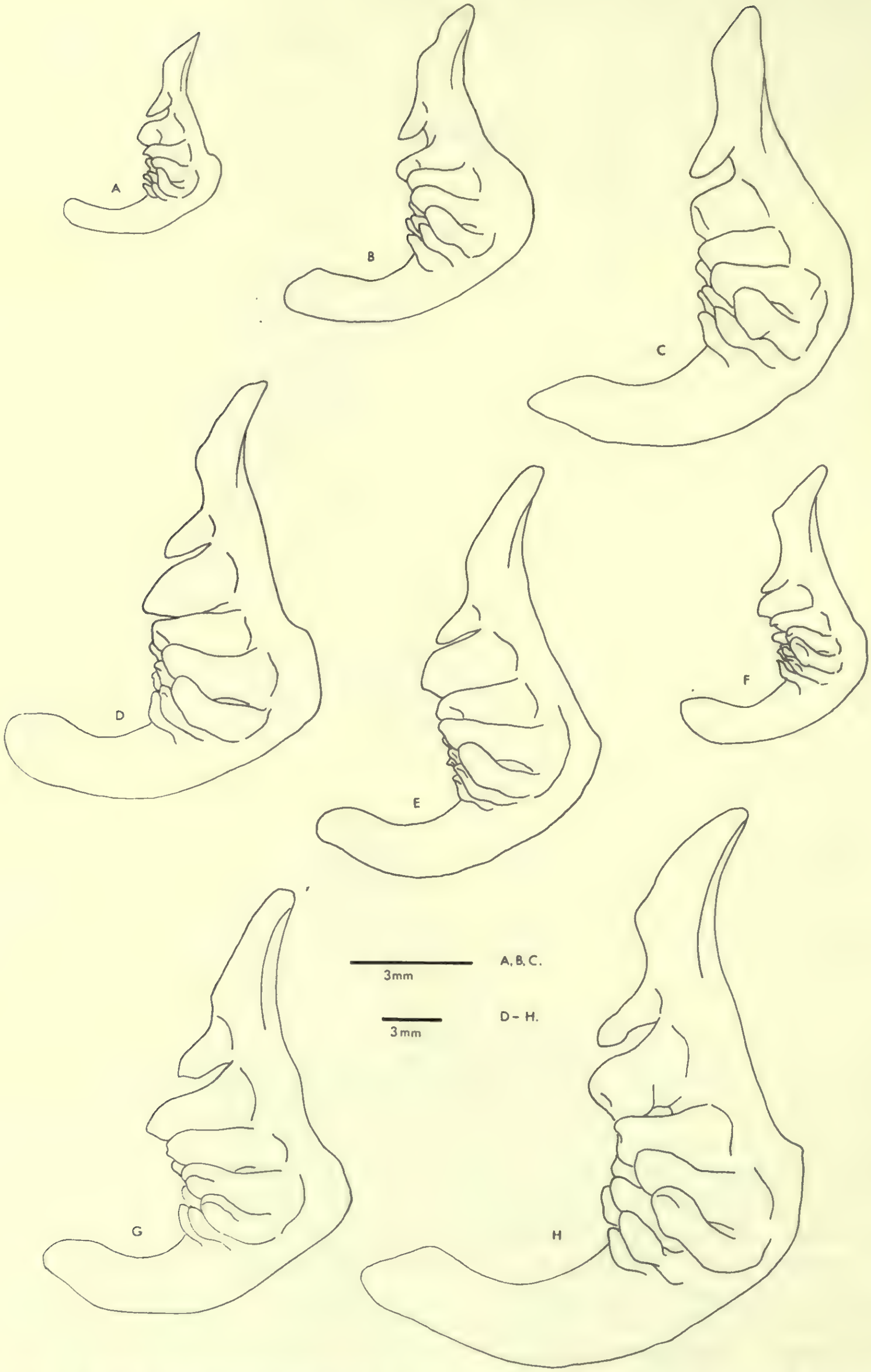

A
B
C
D
E
F
3mm
A, B, C.
3mm
D – H.
G
H

FIG. 19. A series of pharyngeal bones from specimens of *B. bynni* to show the variation with the size of the fish. Standard lengths (mm) of the specimens are A = 58 ; B = 98 ; C = 140 ; D = 260 ; E = 235 ; F = 171 ; G = 280 ; H = 350.

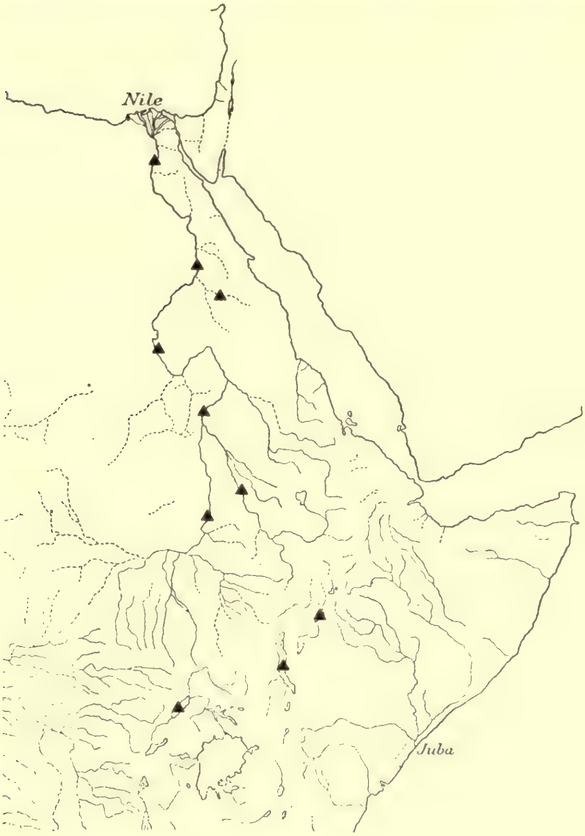


FIG. 20. Map of the distribution of *B. bynni*.

writing on the label inside the gill cover is very faint. This fish is certainly *Barbus bynni* but its locality is in some doubt and it is not included with the data presented above. Its measurements, however, will appear at the end of this section.

Vinciguerra (1898) gives Bissan Guarrica as a locality for *Barbus ruspolii*. As far as I can find out this is a tributary of the Sagan river which drains into Lake Stephanie.

Lakes Rudolf and Abaya are now isolated from the Nile system. Fryer (1968) suggests that the Southern Ethiopian rift valley lakes drained into Lake Rudolf and Lake Rudolf was connected to the Nile via the Sobat river (or via the present Lotagipi and Kenamuki swamps as suggested by Cooke 1958). Therefore *Barbus bynni* could have been isolated in the distal parts of what was once a more extensive Nile system. *Argulus rhipidiophorus*, a parasitic crustacean discussed by Fryer (*op. cit.*) is also found in the Nile, Lake Rudolf and the Ethiopian rift valley lakes. Greenwood (1959) has recorded remains of fishes closely resembling *Barbus bynni* from an epi-Pleistocene site at Ishango near the source of the Semliki river on Lake Edward. *Barbus bynni* is now extinct in Lake Edward (see p. 26).

*Barbus bynni* is confined to the Nile system and is also found in lakes that were once connected to the Nile.

DIAGNOSIS AND AFFINITIES. *Barbus bynni* has some gross morphological characters in common with *Barbus gananensis*, *Barbus oxyrhynchus* and *Barbus longifilis*. The characters in common include a rhomboidal compressed body, a strong, straight, smooth dorsal spine and parallel, sinuous striae on the scales. The species listed above are considered to be closely related and comprise the *Barbus bynni* complex which is discussed further on page 128.

*Barbus bynni* can be distinguished from *Barbus gananensis* by the length and strength of the dorsal spine (longer and stronger in the former species) and by the shape of, particularly, the second tooth in the inner pharyngeal row. In *Barbus gananensis* this tooth is higher and longer than in *Barbus bynni* (see fig. 28). The anterior edentulous process of the pharyngeal bone is relatively longer in *Barbus bynni* than in *Barbus gananensis*.

The other two species are well separated geographically from *Barbus bynni*. *Barbus longifilis* can easily be distinguished by its barbels (Ab, $\bar{x} = 8{\cdot}9$, range 8·3–9·6 ; Pb, $\bar{x} = 11{\cdot}3$, range 9·5–13·4) which are much longer than those of *Barbus bynni* (Ab, $\bar{x} = 4{\cdot}4$, range 1·2–6·9 ; Pb, $\bar{x} = 5{\cdot}5$, range 3·2–8·4).

*Barbus oxyrhynchus* has fewer scales in the lateral line series than has *Barbus bynni* (21–29, most frequently 22–25 against 28–37, most frequently 31–33). The dorsal spine is usually thinner and shorter in *Barbus oxyrhynchus* than in *Barbus bynni* ($\bar{x} = 25{\cdot}3$ in *Barbus oxyrhynchus*, $\bar{x} = 31{\cdot}1$ in *Barbus bynni*).

*Barbus bynni* P.A.S. No. 16710 (see above)

L = 349 mm ; D = 31·0 ; H = 21·8 ; I = 5·4 ; IO = 8·6 ; MW = 5·1 ; Pct = 23·2 ; CPl = 14·6 ; CPd = 13·4 ; Snt = 6·9 ; Ab = 4·0 ; Pb = 4·9 ; DSp = 29·3.

Dorsal fin IV–9. Twelve scales around caudal peduncle ; 31 in lateral line, 5·5 between dorsal mid-line and lateral line, 5·5 from lateral line to ventral mid-line ; 2·5 between lateral line and base of pelvic fin.

## ***Barbus caudovittatus*** Boulenger 1902

*Barbus caudovittatus* Blgr., 1902, *Annls. Mus. r. Congo Belge* Zool. (1) **2** : 32 ; Poll, 1953, *Résult. scient. Explor. hydrobiol. Lac Tanganika* **3** (5A) : 85.
*Varicorhinus stappersii* Blgr., 1917, *Ann. Mag. nat. Hist.* (8) **20** : 364.
*Barbus euchilus* Blgr., 1919, *Proc. zool. Soc. Lond.* : 400.
*Barbus miochilus* Blgr., 1919, *Proc. zool. Soc. Lond.* : 401.
*Barbus lestradei* David, 1936, *Revue Zool. Bot. afr.* **27** (2) : 150, fig. 1.
*Barbus chilotes sakaniae* Poll, 1938, *Revue Zool. Bot. afr.* **30** (3) : 413, fig. 13.
*Barbus pojeri* Poll, 1944, *Bull. Mus. r. Hist. nat. Belg.* **20** (3) : 2, fig. 3.

NOTES ON THE SYNONYMY. Poll (1946) synonymized *Barbus euchilus* and *Barbus miochilus* and then in 1953 included *Barbus pojeri* within the expanded *Barbus euchilus*. After examination of the type specimens I agree with Poll, although it is worth noting that the dorsal fin spines of *Barbus euchilus* and *Barbus miochilus* are more strongly ossified than is the norm in *Barbus caudovittatus*.

*Barbus lestradei* had been recognized as a separate species by authors since its first description by David (1936). The type specimen in the Central African Museum at Tervuren has IV–9 rays in the dorsal fin (not II–9) and 27 scales in the lateral line. It is a large fish (S.L. 373 mm) as are almost all fish referred to *Barbus lestradei*. The body is dark coloured, but the measurements, the weakly ossified dorsal spine, overall body shape and the indications of darkening in body colour in some *Barbus caudovittatus* leave little room for doubt that *Barbus lestradei* is a synonym of *Barbus caudovittatus*. *Varicorhinus stappersii* was described from two specimens of 255 mm and 191 mm S.L. respectively from Nganza on the Lufuko river, Lake Tanganyika basin B.M. (N.H.) Reg. No. 1920.5.25 : 36–37, and two specimens from the same locality, M.A.C.T. No. 14222 of S.L. 175 and 184 mm. The morphometric data for the two B.M. (N.H.) specimens (not included below) are D = 29·0, 29·3 ; H = 20·8, 22·5 ; I = 4·7, 5·8 ; IO = 8·8, 8·6 ; MW = 9·4, 8·6 ; Pct = 21·2, 20·9 ; CPl = 19·2, 19·4 ; CPd = 11·8, 11·5 ; Snt = 7·5, 8·1 ; Ab = 3·9, 4·7 ; Pb = 5·5, 6·5 ; DSp = 9·4, 10·0 ; D. fin IV–10, IV–9. The morphometric data of these two fish are given separately to facilitate a comparison with the morphometric data of the other specimens of *Barbus caudovittatus*. There are 12 scales around the caudal peduncle, 28 in the lateral line, 4·5, 5·5 in the transverse series and 2·5 between the lateral line and base of the pelvic fin. The M.A.C.T. specimens agree closely with these measurements.

The mouth is broad with a straight, horny edge to the lower jaw. The width of the mouth is a natural consequence of achieving the '*Varicorhinus*' facies, as perhaps is the decrease in head length. The barbels are conspicuous and the pharyngeal bones are identical with those of *Barbus caudovittatus*. These features and the similarity between the morphometric data of *Varicorhinus stappersii* and *Barbus caudovittatus* suggest that the two specimens of *Varicorhinus stappersii* are highly modified 'sector' forms of *Barbus caudovittatus* (Groenewald 1958). The situation here parallels the case of *Varicorhinus brucii* and *Barbus brucii*, two species, displaying different facies, that were eventually synonymized by Jubb (1968). It is not within the scope of this paper to discuss the validity of the genus *Varicorhinus*, but there is sufficient awareness of the variability of *Barbus* species mouth parts to suggest that it is not unlikely that some African *Varicorhinus* species are highly modified individuals of various polymorphic *Barbus* species. The specimens from Koki, recorded by Poll (1953), are only doubtfully *Barbus caudovittatus*. The three fishes examined, B.M. (N.H.) 1955.12.20 : 870–872, ex Poll, are small, 43–47 mm S.L. with 10 or 11 branched rays in the dorsal fin, a well-ossified dorsal spine, 24–25 scales in the lateral line and no dark marks on the caudal fin. Although these Koki specimens come from within the distributional limits of *Barbus caudovittatus* I have too little information to decide whether they are a separate species or a distinct population of *Barbus caudovittatus*. They have not been considered to be *Barbus caudovittatus* in this account.

HOLOTYPE. A fish of 77 mm S.L., M.A.C.T. No. 1168, from Banzyville. Another specimen listed as 'one of the types' is in the collections of the British Museum (Natural History) No. B.M. (N.H.) 1901.12.26 : 26.

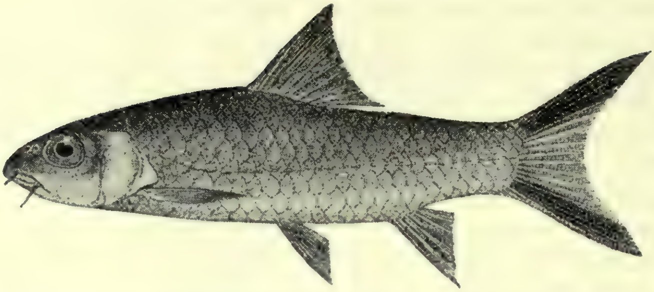


FIG. 21. *Barbus caudovittatus* (Holotype, from Boulenger 1911a).

DESCRIPTION. The description is based on 47 specimens. The morphometric data are expressed in tabular form as follows :

| | x̄ | s.d. | s.e. | range |
|---|---|---|---|---|
| L | | | | 35 –580 mm |
| D | 28·8 | 3·4 | 0·5 | 24·1–37·5 |
| H | 26·6 | 2·0 | 0·3 | 21·4–31·4 |
| I | 7·5 | 1·6 | 0·2 | 4·7–11·4 |
| IO | 9·4 | 1·6 | 0·2 | 6·5–12·4 |
| MW | 7·3 | 0·8 | 0·1 | 5·7– 8·9 |
| Pct | 21·0 | 1·5 | 0·2 | 18·1–24·7 |
| CPl | 16·8 | 1·5 | 0·2 | 12·8–19·7 |
| CPd | 12·2 | 1·4 | 0·2 | 8·6–15·8 |
| Snt | 8·9 | 1·1 | 0·2 | 6·5–11·4 |
| Ab | 4·4 | 1·1 | 0·2 | 2·3– 7·5 |
| Pb | 5·8 | 1·6 | 0·2 | 3·1–11·3 |

Small specimens have a shallow compressed body, but this becomes deeper and thicker in larger fish. The mouth is small, inferior and frequently horse-shoe shaped. Thicker lips have been observed in some larger specimens from Lake Tanganyika, whilst in a specimen from the Luilu river (Sankuru system – Kasai ; M.A.C.T. No. 78925), the 'rubber-lipped' condition is approached.

The ventral profile of the body, from the jaw articulation to the anus, is straight or slightly convex. The illustrated specimen (the holotype) is not typical in this respect. The contrast between the ventral and dorsal profiles is usually greater in larger fishes.

*Dorsal fin.* The dorsal fin has four unbranched rays. In one fish from the Luberizi river (Ruzizi area) there are only three unbranched rays. David (1936) recorded only two unbranched rays in the type specimen of *Barbus lestradei*, but on examination of the type I found that there are four. The last unbranched ray is scarcely ossified and in the majority of specimens articulations persist almost to its base. A specimen from Nyundeulu (an affluent of the Lualaba), M.A.C.T. No.

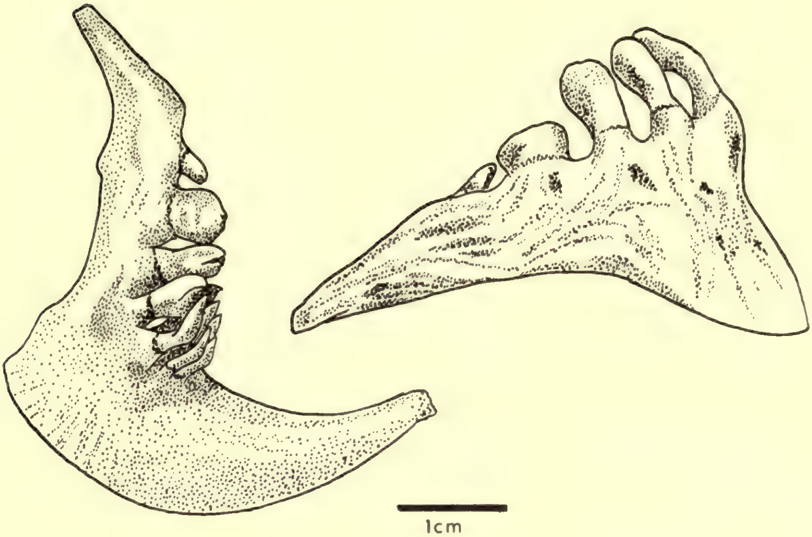


FIG. 22. Dorsal and lateral views of the right pharyngeal bone from a large specimen of *B. caudovittatus* of 420 mm S.L.

124937, has an ossified fourth dorsal ray with a length of 17 per cent of the standard length.

The branched rays range from 8 to 11 in number; 8 (f.3), 9 (f.40), 10 (f.3), 11 (f.1). The fishes with 10 and 11 branched rays in the dorsal fin all come from the river at Elizabethville (= Lubumbashi). The last branched ray is commonly longer than the few rays immediately preceding it.

The anterior edge of the dorsal fin is in advance of the insertion of the pelvic fin. Because of the softness of the last unbranched ray it was impractical to measure its length using the same standards as for the other species.

The *anal fin* has three unbranched and five branched rays.

*Squamation.* The lateral line has 24–30 scales, 24 (f.3), 25 (f.6), 26 (f.12), 27 (f.13), 28 (f.8), 29 (f.4), 30 (f.1). There is no evidence for any geographical variation in these figures. There are 12 scales round the caudal peduncle and 4·5 (r. 5·5) scale rows between the dorsal mid-line and the lateral line and 4·5 (r. 5·5) between the lateral line and the ventral mid-line. Two and a half (r. 3) scale rows are present between the lateral line and the base of the pelvic fin.

*Pharyngeal bones and teeth.* The pharyngeal bones of a large specimen are shown in fig. 22 and of a small specimen in fig. 23.

The crowns of the teeth are hooked in small fishes but become molariform in large fish. No exception to the pharyngeal formula 2.3.5.–5.3.2 was found.

*Gill rakers.* The number of gill rakers on the lower limb of the first gill arch is between 11 and 15 in the specimens examined.

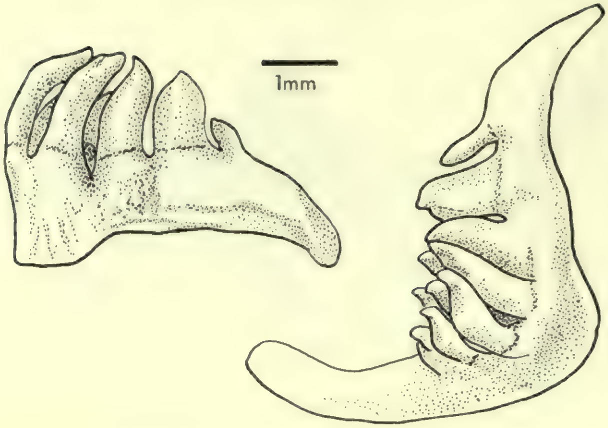


FIG. 23. Left pharyngeal bone from a specimen of *B. caudovittatus* of 110 mm S.L.

*Coloration.* In small specimens (less than about 50 mm S.L.) a small black spot is present on the caudal peduncle at the base of the caudal fin. This spot is not present on larger specimens but instead the dorsal and ventral edges of the caudal fin become darker. In fishes of from about 70 to 170 mm S.L. the dark bands on the caudal fin are conspicuous. Above this size the bands are less obvious as a result of the general darkening of the caudal fin.

In most specimens dark pigment is present on the distal parts of the anal, pelvic and pectoral fins. This is most noticeable in medium-sized fishes.

The body is brown in alcohol-preserved specimens. Large fishes are darker than small fishes.

DISTRIBUTION. Specimens have been examined fom Elizabethville (= Lubumbashi) (Lualaba Congo) ; Banzyville (=Mobayi) (Ubangi Congo) ; Avakubi (Ituri) ; Tshikapa, Luembe, and Tchitatu rivers (upper Kasai) ; Bushiame and Luilu rivers (Sankuru system) ; Dundo, Angola ; Stanleyville (= Kisangani) (Wamba river) ; Yangambe (Isalowe river – Uele system) ; Luberizi river (Ruzizi river) and from Lake Tanganyika.

Poll (1953) thinks that the presence of *Barbus caudovitattus* (as defined here) in Lake Tanganyika is fortuitous and that it essentially is a fluviatile species.

DIAGNOSIS. *Barbus caudovittatus* is a slender-bodied fish characterized by a very soft, poorly ossified last simple ray in the dorsal fin and a dark band on each lobe of the caudal fin. It is most likely to be confused with *Barbus trachypterus* and *Barbus paucisquamatus* which it superficially resembles in body shape, scale counts, and mouth position and mouth shape. It is not yet possible to determine whether these three species are related as I have seen too few specimens of the latter two species. The dorsal spines of *Barbus trachypterus* ($\bar{x}$ = 18·6, range 16·1–21·3) and *Barbus paucisquamatus* ($\bar{x}$ = 19·7, range 14·1–22·5) are much longer and better ossified than is normal in *Barbus caudovittatus*, but a few specimens have developed

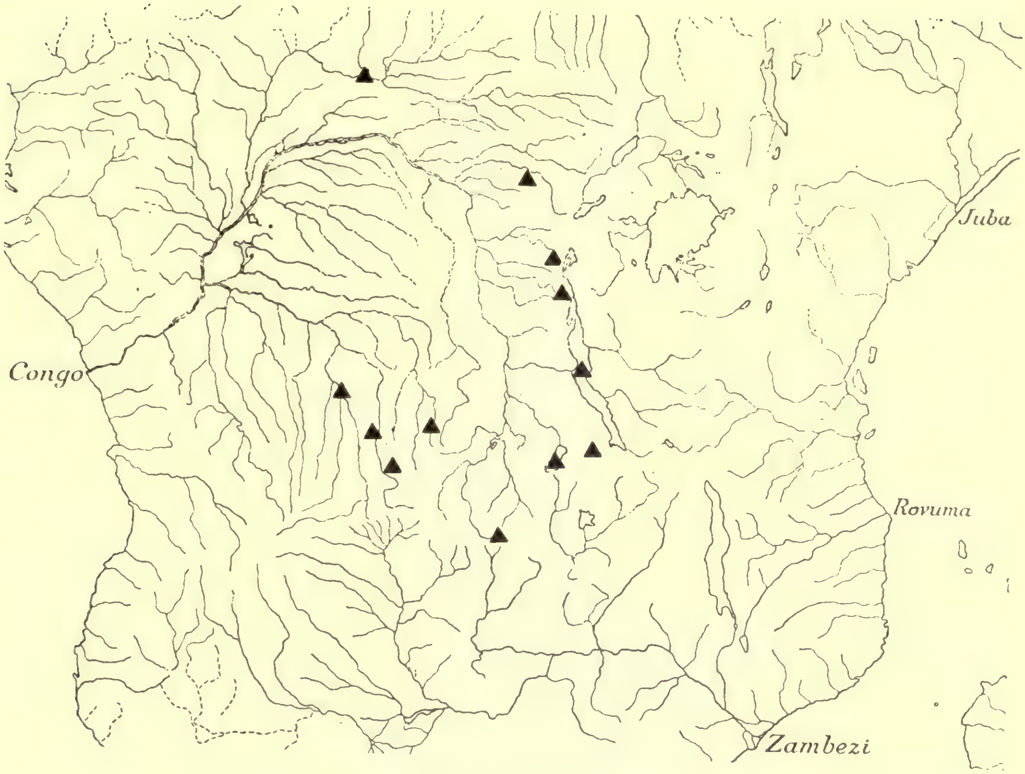


FIG. 24. Map of the distribution of *B. caudovittatus*.

spines of up to 17 per cent S.L. Dark pigment is present on the distal parts of the pectoral, pelvic and anal fins in *Barbus caudovittatus* and *Barbus paucisquamatus* but on the proximal parts of these fins in *Barbus trachypterus*. The barbels are much shorter in *Barbus caudovittatus* (Ab, $\bar{x} = 4{\cdot}4$, range 2·3–7·5 ; Pb, $\bar{x} = 5{\cdot}8$, range 3·1–11·3) than in *Barbus paucisquamatus* (Ab, $\bar{x} = 7{\cdot}5$, range 5·8–10·6 ; Pb, $\bar{x} = 8{\cdot}6$, range 6·2–11·6).

## ***Barbus ethiopicus*** Zolezzi 1939

*Barbus ethiopicus* Zolezzi, 1939, *Boll. Pesca Piscicolt. Idrobiol. Roma* **15** : 369, fig. 1.

HOLOTYPE. A fish of *circa* 230 mm S.L. from Lake Zwai. This specimen has not been seen by me but is the only one described by Zolezzi. The specimen is housed in the Laboratorio centrale di Idrobiologia in Rome.

DESCRIPTION. The description is based on three specimens of 240, 250 and 258 mm collected in Lake Zwai by Mr Eric Hamblyn. B.M. (N.H.) Nos. 1971.7.12 : 1–3.

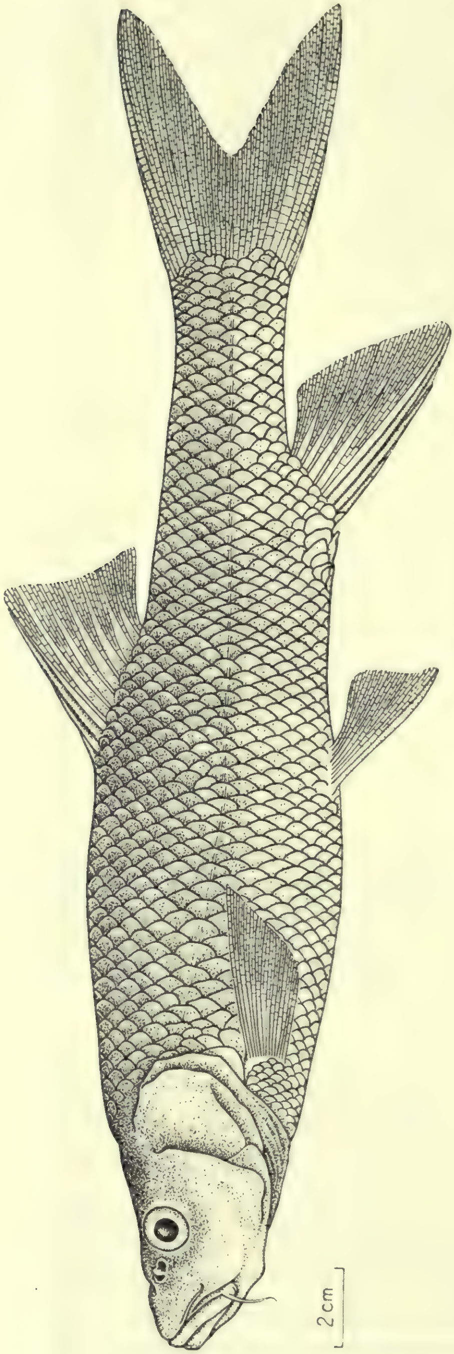


FIG. 25. *Barbus ethiopicus.*

The range of ratios (expressed as percentage of S.L.) for the three specimens is as follows.

| | | | |
|---|---|---|---|
| D | 23·2–24·6 | CPl | 15·8–17·0 |
| H | 25·8–27·1 | CPd | 8·4–10·0 |
| I | 5·8– 6·2 | Snt | 8·8– 9·4 |
| IO | 8·0– 8·8 | Ab | 3·6– 4·2 |
| MW | 7·0– 7·9 | Pb | 3·6– 4·7 |
| Pct | 16·3–18·7 | | |

Calculation of the standard deviation and the standard error with only three specimens was not considered a profitable action.

The elongate body is round in cross-section and the caudal peduncle is long in relation to its depth. The mouth is wide and the gape is terminal. The body was covered with a thick layer of mucus which had to be removed before scale counts could be taken. There are 39 (= 18 + 21) vertebrae.

*Dorsal fin.* The dorsal fin has four unbranched rays. The last unbranched ray is weakly ossified as a smooth spine from 8·4 to 9·6 per cent of the standard length. The three specimens have 6 (f.1), 7 (f.1) or 8 (f.1) branched dorsal fin rays. The holotype has eight. This degree of variation is unusual and the number of branched rays is low for the large *Barbus* species of East Africa although not infrequent in the small *Barbus* species with radiately striated scales. The dorsal fin is inserted slightly in front of the pelvic fins.

The *anal fin* has three unbranched and five branched rays.

*Squamation.* The lateral line has 46 (f.1), 48 (f.1) or 52 scales (48 and 50 on either side of the holotype), a number much higher than in any other large *Barbus* species of the region. There are 18 scales round the caudal peduncle (18–20 in the holotype according to Zolezzi). Between the dorsal mid-line and the lateral line there are 9·5 (f.1) or 10·5 (f.2) scale rows and 10·5 (f.2) or 11·5 (f.1) between the lateral line and the ventral mid-line. Five and a half scale rows are present between the lateral line and the base of the pelvic fin.

*Pharyngeal bones and teeth.* The pharyngeal teeth number 2.3.5.–5.3.2 (fig. 26), the first two teeth in the inner row are conical with small depressions on the posterior face of the crown. In succeeding teeth the concavity becomes larger and as the stem of the tooth becomes thinner the whole tooth assumes a spatulate appearance with a recurved tip.

There are 10 (f.1) or 11 (f.2) *gill rakers* on the lower limb of the first gill arch in the three specimens examined.

*Coloration.* The preserved fishes are olive grey-brown on the back and flanks to just below the lateral line. The ventral part of the flanks and the belly are orangeish to pinkish-brown. The dorsal fin and the dorsal lobe of the caudal fin are olive-brown. The other fins are pale brown.

DISTRIBUTION. Known only from Lake Zwai, Ethiopia.

DIAGNOSIS AND AFFINITIES. *Barbus ethiopicus* is easily distinguished from the other species described in this paper. It has a shallow, almost cylindrical body

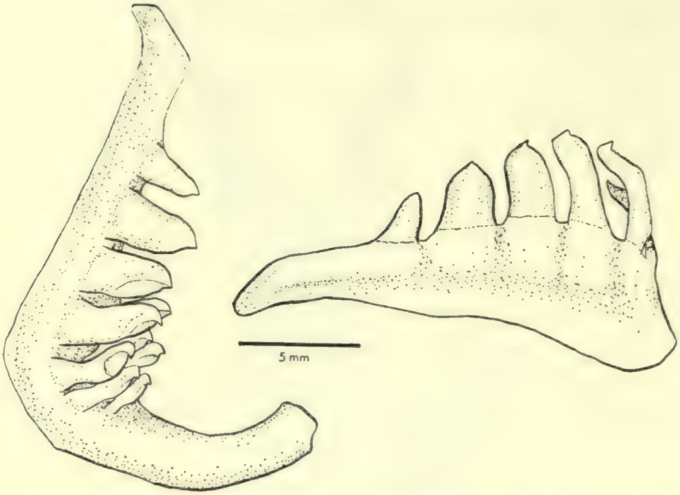


Fig. 26. Left pharyngeal bone of *Barbus ethiopicus*. Dorsal and lateral views.

with more than 46 scales in the lateral line. *Barbus microterolepis*, known by one specimen from a stream flowing into Lake Zwai, has only 40 scales and a much more compressed body.

Small-scaled *Barbus* species from the region under discussion in this paper are confined to lake basins, e.g. *Barbus tropidolepis* and *Barbus platyrhinus* of Lake Tanganyika. However, it is not possible to decide, in these cases, whether the small scales are an adaptation to a primarily lacustrine environment or not. The geological history of the Lake Zwai basin is not known in enough detail to determine how long the lake was isolated from the major rivers of the area and hence whether *Barbus ethiopicus* represents a relict population from a once widespread small-scaled species (and here it must be noted that there are fluviatile small-scaled species in South Africa) or whether it is a modification of, for example, the *Barbus intermedius* stock with which it is now sympatric. *Barbus intermedius* as well as *Barbus microterolepis* is found in Lake Zwai. The possible relationships of the latter species to *Barbus ethiopicus* are discussed on p. 91.

The evidence for the affinities of *Barbus ethiopicus* is inconclusive. There are no characters which preclude its descent from a *Barbus intermedius* stock but equally there are no characters which positively suggest a relationship with such a stock.

In the absence of positive information, the affinities of *Barbus ethiopicus* are left in abeyance and it is not, in this paper, considered to be related to *Barbus intermedius*.

### ***Barbus gananensis*** Vinciguerra 1895

*Barbus gananensis* Vinciguerra, 1895, *Annali Mus. civ. Stor. nat. Giacomo Doria* (2) **15** : 53, pl. 5, fig. 2 ; Vinciguerra, 1897, *Annali Mus. civ. Stor. nat. Giacomo Doria* (2) **17** : 362.

Holotype. The holotype M.S.N.G. (Museo Storia Naturale Genova) No. 17525 from the River Ganana (= Juba) between Lugh and Bardera in Somaliland was

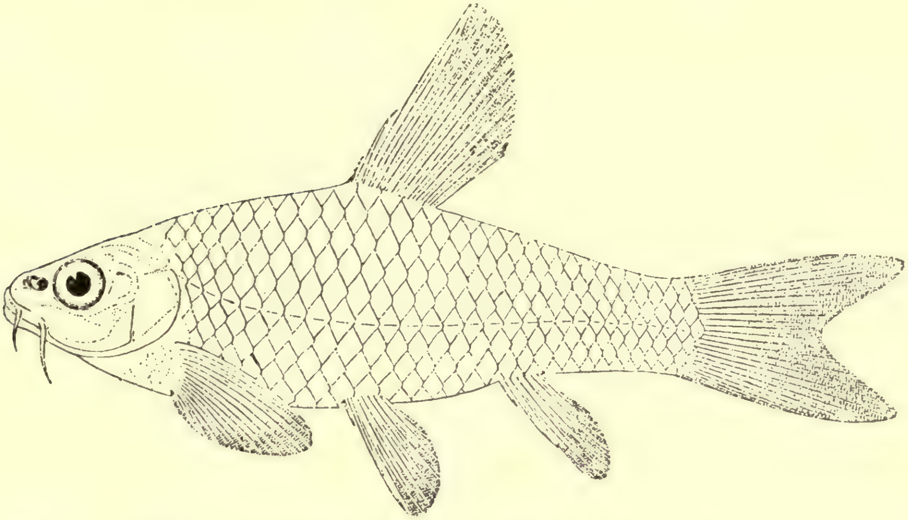


FIG. 27. *Barbus gananensis* (the holotype after Vinciguerra – in Boulenger 1911a).

figured by Vinciguerra. It is now in extremely poor condition and I have not been able to examine it although it was examined for me by Dr E. Tortonese. I have though, through the kindness of Dr E. Tortonese, been able to examine two paralectotypes. These are small fish of 50 and 39 mm S.L. and they came from the Auata river (= Awata). A further specimen from the type locality, a fish of 176 mm S.L., M.S.N.G. No. 17339, was studied and this specimen is illustrated (fig. 28) to compare with the original rather poor figure. A fourth fish, identified as *Barbus gananensis* from the Citerni collection from the Upper Ganana, M.S.N.G. No. 17343, is not referable to this species.

The description is therefore based upon three specimens.

DESCRIPTION. As a result of the description being based on two small fish and one larger specimen, certain morphometric data show a large range. Only the range is shown as other calculations could be misleading.

| | | | |
|---|---|---|---|
| L | 39 –176 mm | Pct | 23·1–24·0 |
| D | 28·2–32·0 | CPl | 16·5–18·0 |
| H | 25·0–28·2 | CPd | 13·1–15·0 |
| I | 7·4–10·2 | Snt | 7·7– 8·0 |
| IO | 6·0– 8·5 | Ab | 2·6– 6·3 |
| MW | 4·5– 7·7 | Pb | 6·0– 7·9 |

The calculations are expressed as percentages of the standard length.

The body is compressed and similar in outline to the body of *Barbus bynni*, although rather less deep. The caudal peduncle is not so square as in *Barbus bynni*, the ratio of the CPl/CPd is from 1·2 to 1·3 in *Barbus gananensis* against 1·0 to 1·2 in *Barbus bynni* of the same size.

*Squamation*. The scales bear parallel striae, slightly less sinuous than is typical for *Barbus bynni*. There are 29 (f.2) or 31 (f.1) scales in the lateral line and 12 scales

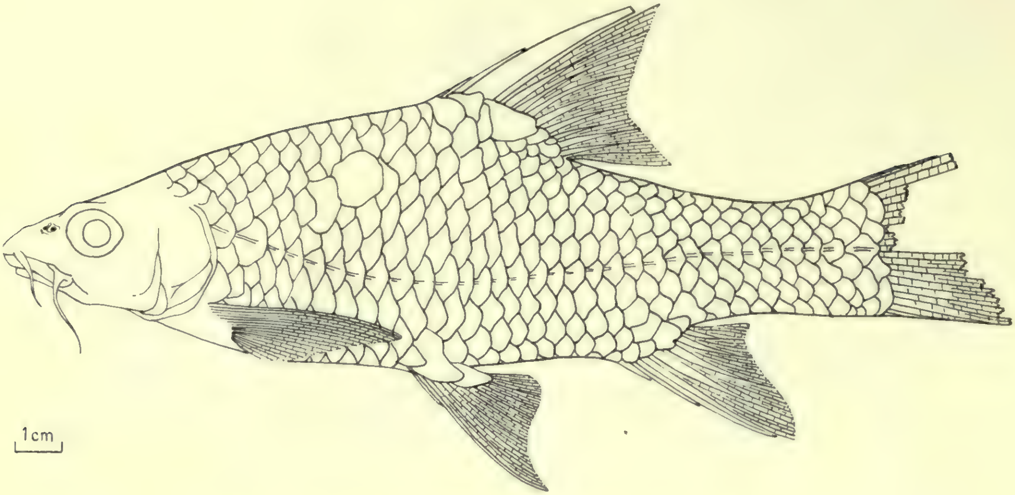


FIG. 28. *Barbus gananensis*, a specimen of 176 mm S.L.

around the caudal peduncle. The other scale counts were only possible for the largest specimen and here there are 5·5 scales between the dorsal mid-line and the lateral line, 5·5 scales between the lateral line and the ventral mid-line and 2·5 scales between the lateral line and the insertion of the pelvic fin.

*Dorsal fin.* The dorsal fin has four unbranched rays and nine branched rays. The base of the fin is enveloped by a sheath of scales. The last unbranched ray forms a smooth ossified spine from 18·0 to 22·7 per cent of the standard length. This is rather less than in similar-sized specimens of *Barbus bynni*. The spine in the small specimens is conspicuously less well ossified than equal-sized *Barbus bynni* specimens. The origin of the dorsal fin is slightly in advance of the origin of the pelvic fin.

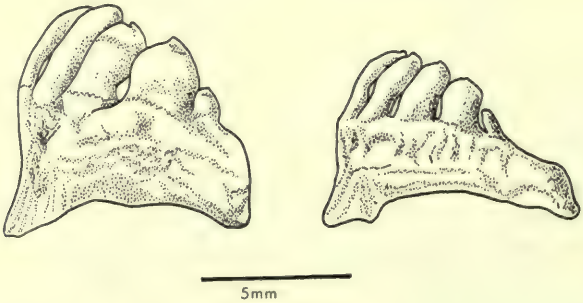


FIG. 29. A comparison of the left pharyngeal bones from a specimen of *B. gananensis* of 176 mm S.L. (left bone) with the left pharyngeal bone from a *Barbus bynni* of 171 mm S.L.

The *anal fin* has three unbranched rays and five branched rays. The last branched ray is markedly bifurcated.

*Pharyngeal bones and teeth.* The contrast between the pharyngeal bones of the 176 mm S.L. *Barbus gananensis* and a 171 mm S.L. *Barbus bynni* can be seen in fig. 29. The bone is thicker and deeper in the former and the teeth of the inner row are higher. The second tooth of the inner row in particular is much longer in *Barbus gananensis* than in *Barbus bynni*. These differences are equally clear in the pharyngeal bones of the smaller *Barbus gananensis* when compared with equal-sized *Barbus bynni*. The teeth of the second and third rows are only marginally more robust than in comparable *Barbus bynni* material.

*Gill rakers.* There are 12 gill rakers on the lower limb of the first gill arch in the largest specimen ; the gill rakers could not be counted in the smaller specimens.

*Coloration.* In alcohol, the young fish are silvery flanked, with a brown back. The largest fish is sandy brown on the flanks and belly, darker on the back.

DISTRIBUTION. Collected from the Juba river (between Lugh and Bardera) and from the Awata river (upper Juba). Also it is reported from the confluence of the Ganana Dulei and Bas Nabor. It has not been recorded from the Webi Shebeli where *Barbus bynni* is found.

AFFINITIES. A species that is very close to *Barbus bynni*, differing in certain features mentioned above. A larger collection of *Barbus gananensis* may show modal differences further distinguishing it from *Barbus bynni*. The general impression culled from these three fish is that they resemble a *Barbus bynni* stock which has begun to approach the facies of the *Barbus oxyrhynchus* from the Athi and Tana systems immediately to the south, particularly in possessing slightly longer pectoral fins than is typical for *Barbus bynni* at these sizes, a reduced dorsal fin spine and no less than nine branched rays in the dorsal fin. However, this is based solely on an extremely small sample of fish and this trend (if it exists) must remain hypothetical until more information is available about *Barbus gananensis*.

## ***Barbus intermedius*** Rüppell 1837

*Barbus surkis* Rüppell, 1837, *Mus. senckenb.* **2** : 5, pl. 1, fig. 1† ; Blgr., 1902, *Ann. Mag. nat. Hist.* (7) **10** : 424 ; Blgr., 1907, *Fish Nile* : 226, pl. 42 ; Blgr., 1911, *Cat. Afr. Fish* **2** : 65.

*Barbus intermedius* Rüpp., 1837, *Mus. senckenb.* **2** : 7, pl. 1, fig. 2 ; Günther, 1864, *Proc. zool. Soc. Lond.* : 91 (non *B. intermedius* Rüpp. – *fide* Blgr., 1911 : 45) ; Blgr., 1902, *Ann. Mag. nat. Hist.* (7) **10** : 424 ; Blgr., 1907, *Fish Nile* : 228, pl. 29, fig. 2 ; Blgr., 1911, *Cat. Afr. Fish* **2** : 59, fig. 39.

† In *Tracts on Natural History*, vol. 4, in the Zoological Department library of the British Museum (Natural History) (Cat. No. 5 q T r) there is a separate of this Rüppell paper bearing the date 1835. The title page, pagination and figures are identical with those in the 1837 *Mus. senckenb.* except that the title page bears the inscription 'Ausgezogen aus dem II Band des Museum Senckenbergianum. Frankfurt am Main, 1835'.

As the cover of the second volume of the *Mus. senckenb.* bears the date 1836 and the title page the date 1837, I am assuming that the 1835 date is either a typographical error or an over-optimistic estimate of the date of publication. Until firm evidence to the contrary is available I shall continue to refer to Rüppell 1837.

*Barbus intermedius leptosoma* : Bini, 1940, *Missione Stud. Lago Tana*, **3** (2) : 167, pl. 6, fig. 1 (vide *B. leptosoma* Blgr., 1902).

*Barbus intermedius microstoma* Bini, 1940, *Missione Stud. Lago Tana*, **3** (2) : 168, pl. 6, fig. 2.

*Barbus intermedius gorgorensis* Bini, 1940, *Missione Stud. Lago Tana*, **3** (2) : 168, pl. 6, fig. 3.

*Barbus affinis* Rüpp., 1837, *Mus. senckenb.* **2** : 8, pl. 1, fig. 3 ; Blgr., 1902, *Ann Mag. nat. Hist.* (7) **10** : 425 ; Blgr., 1907, *Fish Nile* : 216, pl. 29, fig. 1 ; Blgr., 1911, *Cat. Afr. Fish* **2** : 47, fig. 28.

*Barbus affinis brevibarbis* : Bini, 1940, *Missione Stud. Lago Tana*, **3** (2) : 162, pl. 1, fig. 2 (*vide B. brevibarbis* Blgr., 1902).

*Barbus affinis nedgia* : Bini, 1940, *Missione Stud. Lago Tana*, **3** (2) : 163, pl. 2, figs. 1 and 2 (vide *Labeobarbus nedgia* Rüpp., 1837).

*Barbus gorguarii* Rüpp., 1837, *Mus. senckenb.* **2** : 9, pl. 1, fig. 4 ; Blgr., 1902, *Ann. Mag. nat. Hist.* (7) **10** : 424 ; Blgr., 1907, *Fish Nile* : 237, pl. 44 ; Blgr., 1911, *Cat. Afr. Fish* **2** : 75, fig. 53.

*Barbus gorguarii macrophtalmus* Bini, 1940, *Missione Stud. Lago Tana*, **3** (2) : 177, pl. 12, fig. 2.

*Barbus elongatus* Rüpp., 1837, *Mus. senckenb.* **2** : 11, pl. 2, fig. 1.

*Labeobarbus nedgia* Rüpp., 1837, *Mus. senckenb.* **2** : 14, pl. 2, fig. 3.

*Barbus nedgia* (Rüppell) : Günther, 1868, *Cat. Fish* **7** : 104 ; Blgr., 1902, *Ann. Mag. nat. Hist.* (7) **10** : 426 ; Blgr., 1907, *Fish Nile* : 223, pl. 41, fig. 2 ; Blgr., 1911, *Cat. Afr. Fish* **2** : 51, fig. 32.

*Barbus gregorii* Blgr., 1902, *Ann. Mag. nat. Hist.* (7) **10** : 422 ; Blgr., 1911, *Cat. Afr. Fish* **2** : 45.

*Barbus rueppelli* Blgr., 1902, *Ann. Mag. nat. Hist.* (7) **10** : 427 ; Blgr., 1911, *Cat. Afr. Fish* **2** : 26, fig. 7.

*Barbus macronema* Blgr., 1902, *Ann. Mag. Nat. Hist.* (7) **10** : 427 ; Blgr., 1911, *Cat. Afr. Fish* **2** : 25.

*Barbus macronema var. parenzani* Zolezzi, 1940, *Boll. Pesca. Piscic. Idrobiol.* **15** : 372.

*Barbus harringtoni* Blgr., 1902, *Ann. Mag. nat. Hist.* (7) **10** : 429 ; Blgr., 1911, *Cat. Afr. Fish* **2** : 61, fig. 40.

*Barbus plagiostomus* Blgr., 1902, *Ann. Mag. nat. Hist.* (7) **10** : 429 ; Blgr., 1907, *Fish Nile* : 232, pl. 38, fig. 2 ; Blgr., 1911, *Cat. Afr. Fish* **2** : 68, fig. 47.

*Barbus jarsinus* Blgr., 1902, *Ann. Mag. nat. Hist.* (7) **10** : 429 ; Blgr., 1911, *Cat. Afr. Fish* **2** : 62, fig. 41.

*Barbus platystomus* Blgr., 1902, *Ann. Mag. nat. Hist.* (7) **10** : 430 ; Blgr., 1907, *Fish Nile* : 234, pl. 40, fig. 2 ; Blgr., 1911, *Cat. Afr. Fish* **2** : 73, fig. 51.

*Barbus platystomus var. vatovae* Zolézzi, 1939, *Boll. Pesca. Piscic. Idrobiol.* **15** : 370.

*Barbus platystomus platystomus* : Bini, 1940, *Missione Stud. Lago Tana*, **3** (2) : 170, pl. 8, fig. 1.

*Barbus platystomus daga* Bini, 1940, *Missione Stud. Lago Tana*, **3** (2) : 171, pl. 8, fig. 2.

*Barbus platystomus dekkensis* Bini, 1940, *Missione Stud. Lago Tana*, **3** (2) : 172, pl. 9, fig. 1.

*Barbus platystomus prognathus* Bini, 1940, *Missione Stud. Lago Tana*, **3** (2) : 173, pl. 9, fig. 2.

*Barbus brevibarbis* Blgr., 1902, *Ann. Mag. nat. Hist.* (7) **10** : 431 ; Blgr., 1907, *Fish Nile* : 219, pl. 35, fig. 2 ; Blgr., 1911, *Cat. Afr. Fish* **2** : 49, fig. 29.

*Barbus kassamensis* Blgr., 1902, *Ann. Mag. nat. Hist.* (7) **10** : 431 ; Blgr., 1911, *Cat. Afr. Fish* **2** : 30, fig. 11.

*Barbus oreas* Blgr., 1902, *Ann. Mag. nat. Hist.* (7) **10** : 432 ; Blgr., 1911, *Cat. Afr. Fish* **2** : 38, fig. 19 ; Pietschmann, 1913, *Jb. Ver. Naturk. Wiesbaden* **66** : 189.

*Barbus leptosoma* Blgr., 1902, *Ann. Mag. nat. Hist.* (7) **10** : 432 ; Blgr., 1907, *Fish Nile* : 220, pl. 40, fig. 1 ; Blgr., 1911, *Cat. Afr. Fish* **2** : 50, fig. 30.

*Barbus duchesnii* Blgr., 1902, *Ann. Mag. nat. Hist.* (7) **10** : 433 ; Pellegrin, 1905, *Bull. Mus. Hist. nat. Paris* **11** : 291 ; Blgr., 1907, *Fish Nile* : 208, pl. 35, fig. 1 ; Blgr., 1911, *Cat. Afr. Fish* **2** : 31, fig. 12.

*Barbus duchesnii maximus* Bini, 1940, *Missione Stud. Lago Tana*, **3** (2) : 165, pl. 4, fig. 2.

*Barbus duchesnii ibridus* Bini, 1940, *Missione Stud. Lago Tana*, **3** (2) : 166, pl. 5.

*Barbus mento* Blgr., 1902, *Ann. Mag. nat. Hist.* (7) **10** : 434 ; Blgr., 1911, *Cat. Afr. Fish* **2** : 41, fig. 22.

*Barbus hursensis* Blgr., 1902, *Ann. Mag. nat. Hist.* (7) **10** : 434 ; Blgr., 1911, *Cat. Afr. Fish* **2** : 46, fig. 27.
*Barbus degeni* Blgr., 1902, *Ann. Mag. nat. Hist.* (7) **10** : 435 ; Blgr., 1907, *Fish Nile* : 222, pl. 41, fig. 1 ; Blgr., 1911, *Cat. Afr. Fish* **2** : 50, fig. 31.
*Barbus degeni leptorhinus* Bini, 1940, *Missione Stud. Lago Tana,* **3** (2) : 164, pl. 3, fig. 2.
*Barbus erlangeri* Blgr., 1903, *Proc. zool. Soc. Lond.* (2) : 329, pl. 29 ; Blgr., 1911, *Cat. Afr. Fish* **2** : 29, fig. 10.
*Capoeta bingeri* Pellegrin, 1905, *Bull. Mus. Hist. nat. Paris* **11** : 292.
*Barbus ilgi* Pellegrin, 1905, *Bull. Mus. Hist. nat. Paris* **11** : 293.
*Barbus neuvillii* Pellegrin, 1905, *Bull. Mus. Hist. nat. Paris* **11** : 294.
*Barbus zuaicus* Blgr., 1906, *Ann. Mag. nat. Hist.* (7) **17** : 562 ; Blgr., 1911, *Cat. Afr. Fish* **2** : 64, fig. 43.
*Barbus macmillani* Blgr., 1906, *Ann. Mag. nat. Hist.* (7) **17** : 562 ; Blgr., 1911, *Cat. Afr. Fish* **2** : 67, fig. 46.
*Barbus zaphiri* Blgr., 1906, *Ann. Mag. nat. Hist.* (7) **17** : 563 ; Blgr., 1907, *Fish Nile* : 235, pl. 45, fig. 1 ; Blgr., 1911, *Cat. Afr. Fish* **2** : 74, fig. 52.
*Barbus bottegi* Blgr., 1906, *Ann. Mag. nat. Hist.* (7) **17** : 563 ; Blgr., 1911, *Cat. Afr. Fish* **2** : 70, fig. 48.
*Barbus gudaricus* Blgr., 1906, *Ann. Mag. nat. Hist.* (7) **17** : 564 ; Blgr., 1907, *Fish Nile* : 241, pl. 34, fig. 2 ; Blgr., 1911, *Cat. Afr. Fish* **2** : 40, fig. 21.
*Barbus eumystus* Blgr., 1906, *Ann. Mag. nat. Hist.* (7) **17** : 565 ; Blgr., 1907, *Fish Nile* : 215, pl. 38, fig. 1 ; Blgr., 1911, *Cat. Afr. Fish* **2** : 44, fig. 25.
*Barbus margaritae* Blgr., 1906, *Ann. Mag. nat. Hist.* (7) **17** : 565 ; Blgr., 1911, *Cat. Afr. Fish* **2** : 39, fig. 20.
*Barbus alticola* Blgr., 1906, *Ann. Mag. nat. Hist.* (7) **17** : 566 ; Blgr., 1911, *Cat. Afr. Fish* **2** : 55, fig. 35.
*Barbus bingeri* : Blgr., 1911, *Cat. Afr. Fish* **2** : 69.
*Barbus procatopus* Blgr., 1916, *Ann. Mag. nat. Hist.* (8) **17** : 244.
*Barbus volpinii* Parenzan, 1940, *Boll. Idrobiol. Cacc. Pesca. Afr. orient. ital.* **1** : 9, fig. 1.
*Barbus brunellii* Bini, 1940, *Missione Stud. Lago Tana,* **3** (2) : 173
*Barbus brunellii acutirostris* Bini, 1940, *Missione Stud. Lago Tana,* **3** (2) : 174.
*Barbus dainellii* Bini, 1940, *Missione Stud. Lago Tana,* **3** (2) : 175.
*Barbus dainellii macrocephalus* Bini, 1940, *Missione Stud. Lago Tana,* **3** (2) : 176.
*Varicorhinus bingeri* : Bertin and Estève, 1947, *Catalogue des Types des Poissons,* Paris **4** : 44.

NOTES ON THE SYNONYMY. Although the specific name *surkis* appears before *intermedius* in Rüppell (1837), I have selected the latter name as the senior synonym according to article 24 of the International Code. The reasons for this are : a) Rüppell's text states that *Barbus surkis* has 36 scales in the lateral line but his illustration (pl. 1, fig. 1) shows only 32 scales ; the text and figure of *Barbus intermedius* agree with the holotype ; b) the holotype of *Barbus surkis* is untraceable but the holotype of *Barbus intermedius* exists as specimen 6778 in the Senckenberg Museum, Frankfurt-am-Main ; c) the specific name *intermedius* is a great deal more apposite for this variable species than is *surkis*.

A synonymy as extensive as this, involving 50 nominal species and subspecies and resulting in one species with two subspecies requires a great deal of justification. The evidence will be presented below.

Just over a hundred years after Rüppell described the deep-bodied *Barbus surkis* Bini (1940) described the elongated, predatory-looking *Barbus brunellii*. These two species, ironically the first and (to date) the last described from Lake Tsana, are very different in shape (see figs. 31, 32 and 46) and a simple comparison of an example of each form would undoubtedly result in their being placed in separate species. It is only when the extremes are compared with other Ethiopian specimens that it becomes evident that one variable species is present instead of many, scarcely distinct species. The degree of variability is great and is reflected throughout many parts of the bodies of species ; head length may be singled out as one of the most variable factors. Because of this plasticity of form it has proved impossible to detect more than two statistically recognizable groups within the whole sample. It had been suspected by Worthington (1932a) that this would be the case from the practical difficulties he encountered in trying to distinguish one nominal species from another using the published descriptions.

The majority of species were described between 1902 and 1906, usually from a very few, often poorly preserved specimens. The species were defined on the basis of small differences in barbel lengths, lip formation, scale counts and body proportions ; differences that may be tenable with few specimens but lose their significance with a large series. Subsequent workers have tried with increasing difficulty to fit newly acquired specimens into the framework of species established by Boulenger (1911a, 1916). Bini (1940) reduced several of Boulenger's species to subspecific rank but at the same time described a further two species. Worthington (1932a : 127) from his work on the Kenyan and Ugandan lakes prophetically commented, 'thus, when a large series of specimens is collected from Lake Tsana and the upper tributaries of the Blue Nile, it is probable that the series of species endemic to the region – *Barbus leptosoma*, *Barbus degeni*, *Barbus nedgia* etc., will prove to be one and the same species since they differ from each other almost solely in the degree of lip development and in the size of the eye and dorsal spine'.

The graphs and calculations presented below will, I hope, show the essentially normal distributions of the characters heretofore considered trenchant, and that it is biologically more reasonable to suggest the presence of one variable species rather than a multitude of almost indistinguishable, ill-defined or indefinable species.

The illustrations reproduced from Boulenger (1911a) and Bini (1940) will help to supplement the calculations and show the various intergrades between the most extreme forms.

Worthington (1932a : 124) noted that the fishes listed by Boulenger (1911) as *Barbus bynni* from Lake Baringo should be placed with *Barbus gregorii* (= *Barbus intermedius*).

Mann (1971) suggests that *Barbus gregorii* from Lake Baringo is rightfully placed with *Barbus tanensis* (= *Barbus oxyrhynchus*). His comparative material was limited to small fishes (less than 60 mm S.L.) which can give rise to misleading conclusions if compared with larger fish. In the scale counts, nature of the scale striae and in most morphometric details the Lake Baringo fishes are identical with *Barbus intermedius* from Ethiopia. However, the dorsal spine is modally longer than in the other *Barbus intermedius* populations (although the spine is not as thick as in *Barbus tanensis*) and the pectoral fin is longer. Because of these characters and because Lake Baringo is isolated and the most southern locality for this species, I think it would be valid to accord sub-specific status to the *Barbus intermedius* population in Lake Baringo and I propose the name *Barbus intermedius australis*.

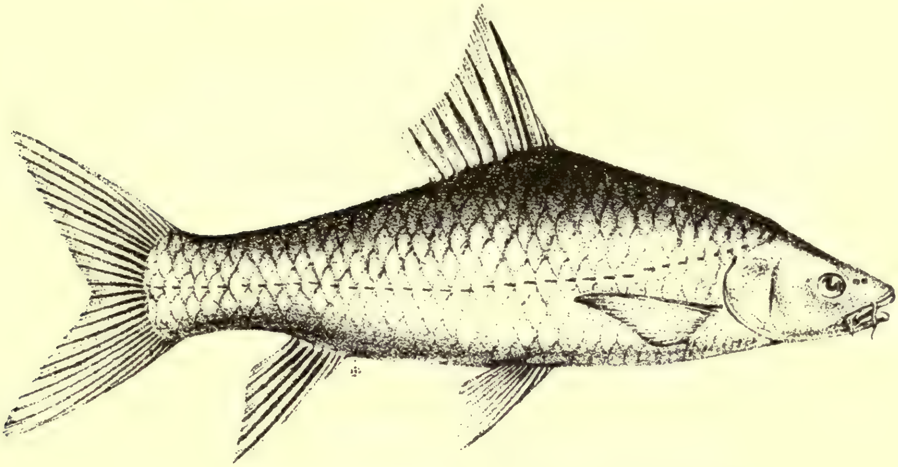


FIG. 30. *Barbus intermedius* (Holotype from Rüppell 1837).

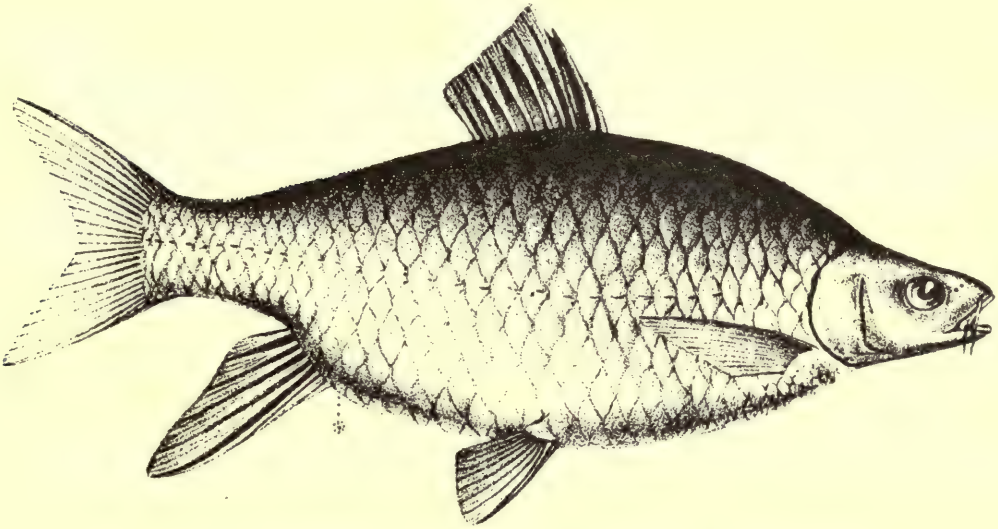


FIG. 31. *Barbus intermedius* (Holotype of *B. surkis* from Rüppell 1837).

It is perhaps worth noting that the longer dorsal spine and longer pectoral fin which distinguish the Lake Baringo population are two characters possessed in greater degree by *Barbus oxyrhynchus*.

HOLOTYPE. A dried specimen of 296 mm S.L. No. 6778, Senckenberg Museum, Frankfurt-am-Main.

DESCRIPTION. The description is based on a total of 454 specimens ; 179 from Lake Tsana, 58 from Lake Baringo, 44 from Lake Abaya, 32 from Lake Zwai, 32 from the Hawash river, 30 from Lake Stephanie, 29 from the Blue Nile, 24 from

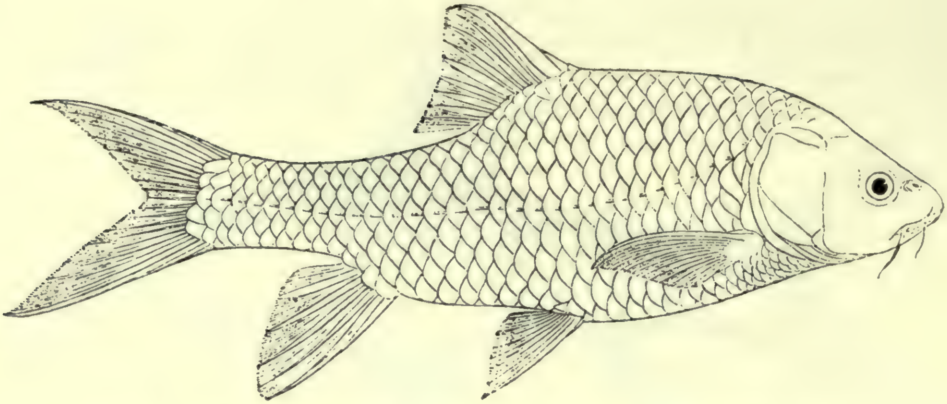


FIG. 32. *Barbus intermedius* (figure of *B. surkis* from Boulenger 1911a).

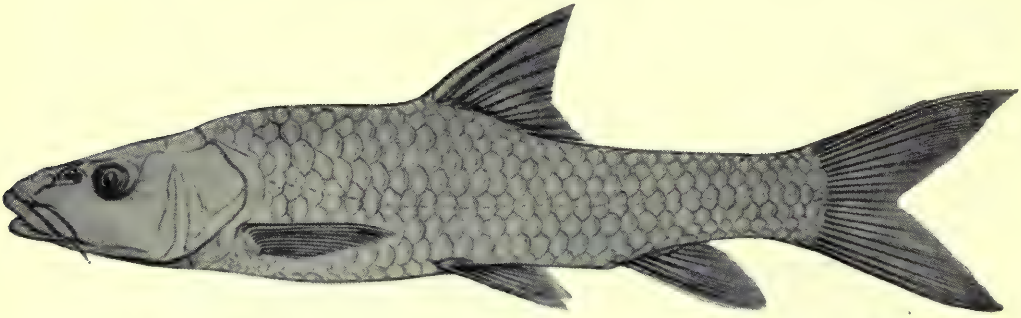


FIG. 33. *Barbus intermedius* (Holotype of *B. dainellii* from Bini 1940).

Lake Rudolf and the Omo river, 21 from the Webi Shebeli river, four from Lake Langano and one from Lake Orsodi.

All traceable holotypes have been examined ; those not seen were *Barbus surkis* (Frankfurt, missing since the war), *Barbus volpinii* (not traceable), *Barbus macronema* var. *parenzani* (not traceable) and *Barbus dainellii* (lost through poor preservation).

| | n | x̄ | s.d. | s.e. | range |
|---|---|---|---|---|---|
| L | 454 | | | | 66 –489 mm |
| D | 454 | 28·4 | 2·3 | 0·1 | 20·7–37·7 |
| H | 454 | 26·4 | 2·2 | 0·1 | 19·0–31·7 |
| I | 454 | 5·9 | 1·2 | 0·05 | 3·5–10·2 |
| IO | 454 | 8·0 | 0·8 | 0·03 | 4·7–12·3 |
| MW | 450 | 5·9 | 1·0 | 0·04 | 3·6– 9·1 |
| Pct | 452 | 21·8 | 1·8 | 0·1 | 15·6–28·0 |
| CPl | 454 | 16·9 | 1·6 | 0·1 | 11·7–22·9 |
| CPd | 453 | 11·6 | 1·2 | 0·1 | 8·0–15·0 |
| Snt | 454 | 8·5 | 1·1 | 0·05 | 5·5–12·7 |
| Ab | 449 | 5·8 | 1·9 | 0·1 | 1·8–11·1 |
| Pb | 451 | 6·9 | 2·1 | 0·1 | 1·9–12·1 |

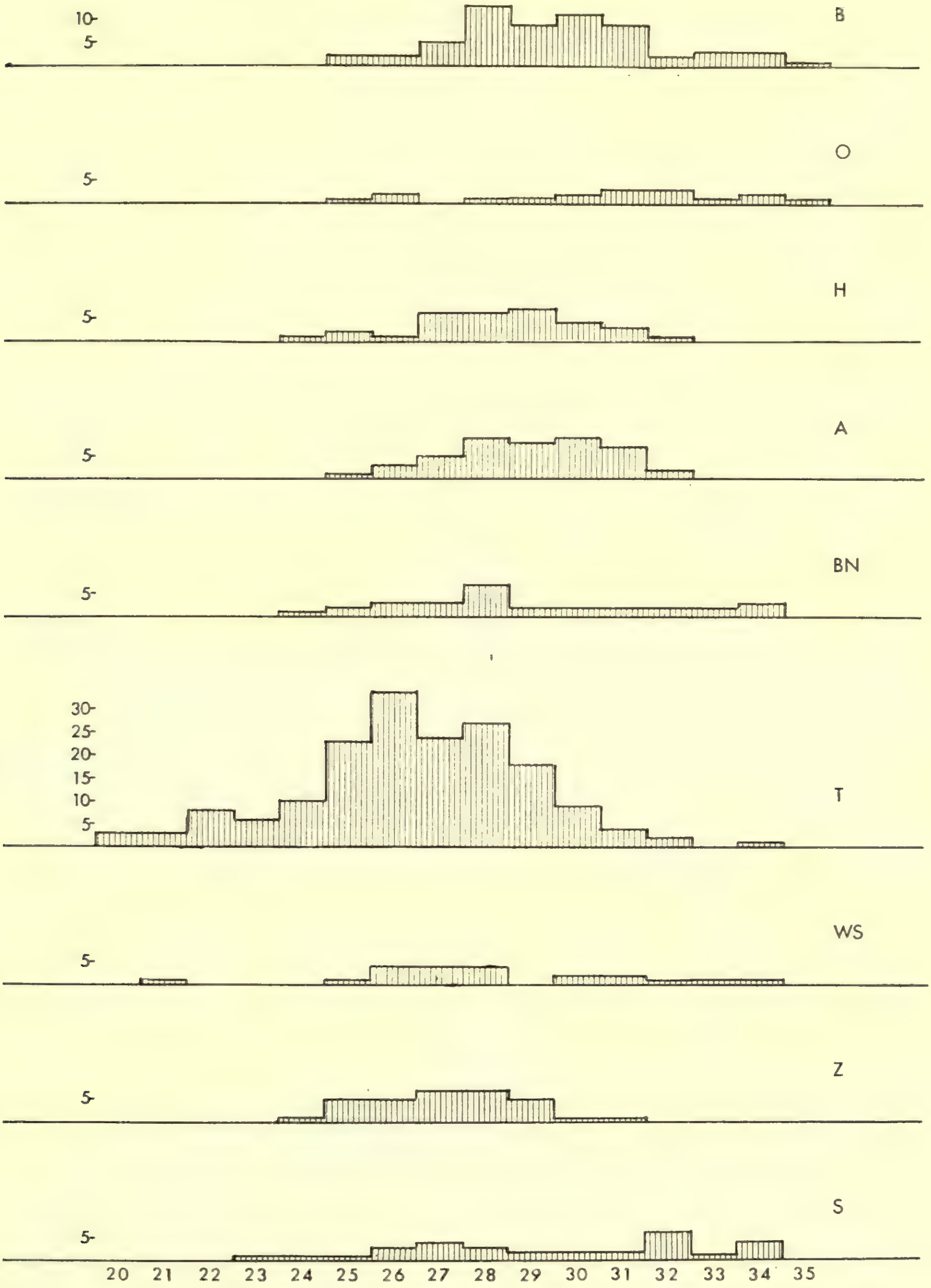


FIG. 34. Histograms of the distribution of the body depth (as a percentage of the standard length) in *B. intermedius* populations from various localities. B = Lake Baringo; O = Omo river; H = Hawash river; A = Lake Abaya; BN = Blue Nile; T = Lake Tsana; WS = Webi Shebeli River; Z = Lake Zwai; S = Lake Stephanie.

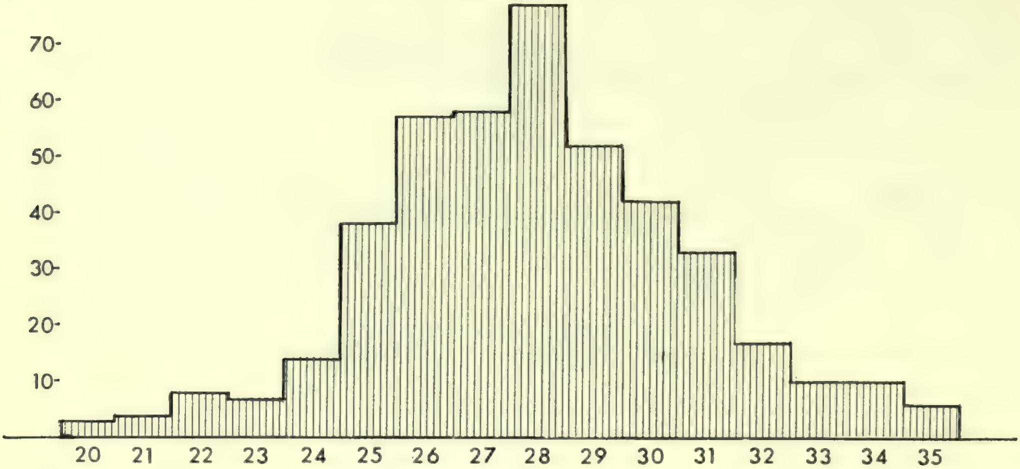


FIG. 35. *Barbus intermedius*: a composite histogram of the body depth for specimens from all the localities treated separately in Fig. 34. The distribution of body depth throughout the whole *B. intermedius* sample is normal.

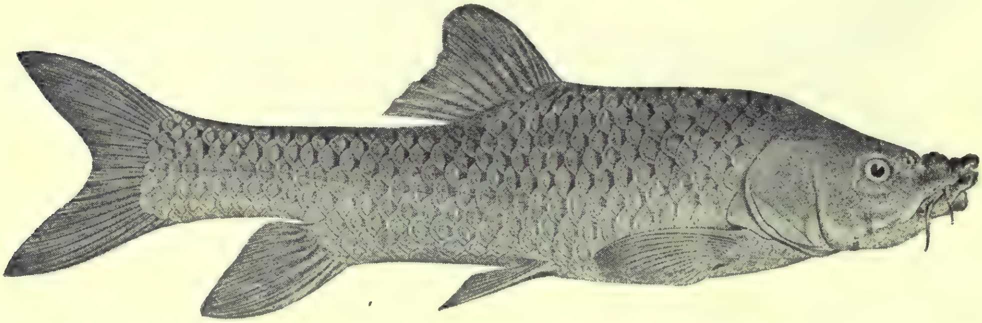


FIG. 36. *Barbus intermedius* (Holotype of *B. degeni* from Boulenger 1911a).

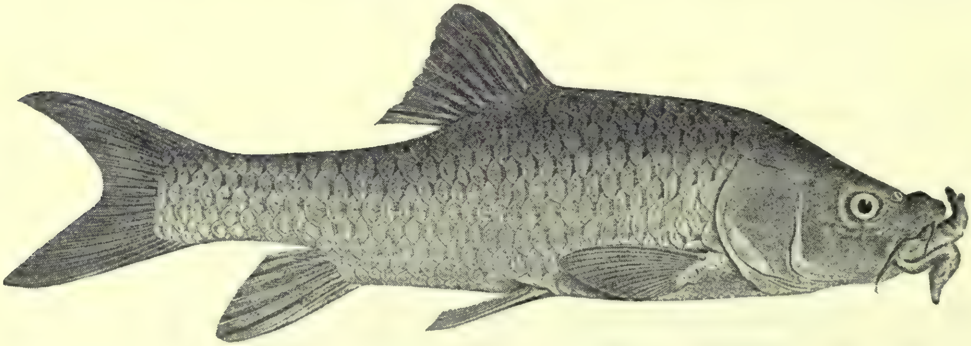


FIG. 37. *Barbus intermedius* (figured specimen of *B. nedgia* in Boulenger 1911a).

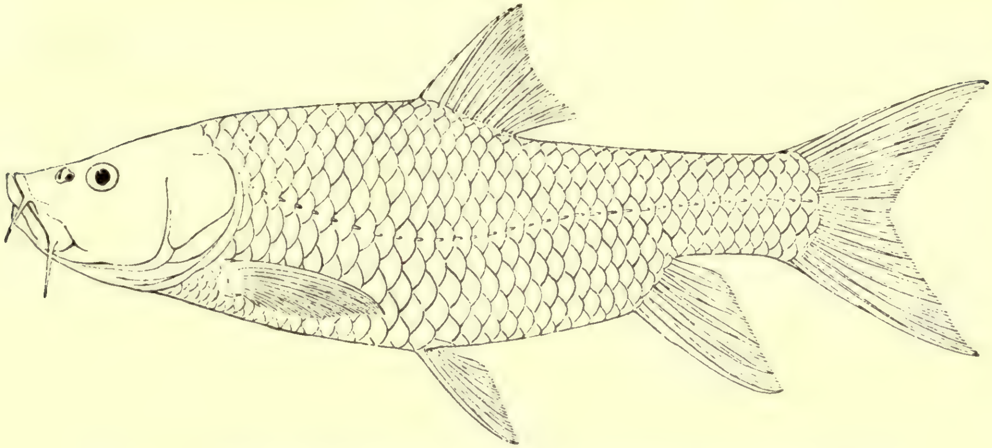


FIG. 38. *Barbus intermedius* (Holotype of *B. rueppelli* in Boulenger 1911a).

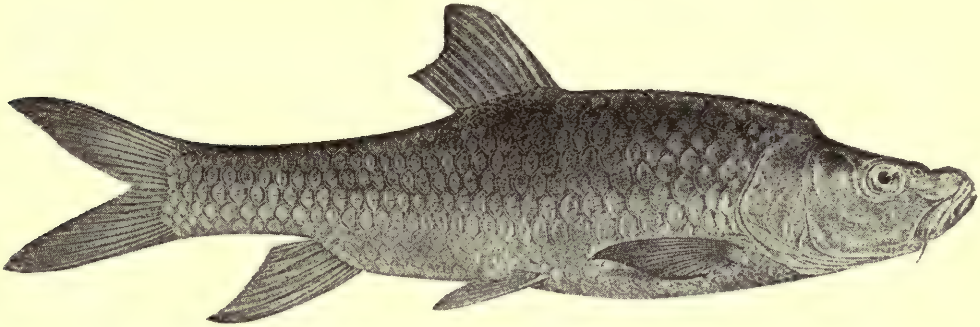


FIG. 39. *Barbus intermedius* (figured specimen of *B. gorguarii* from Boulenger 1911a).

The morphometric data do not adequately reflect the variation in body form shown by this species. A series of examples of different facies is shown in figs. 36 to 44. Names synonymized above are used below for convenience.

The body varies in shape from the slender *Barbus dainellii* form (fig. 33) to the deep *Barbus surkis* form (fig. 32). It can be seen, though, from the histograms that in the whole sample the body depth has a normal distribution (figs. 34, 35). There is a little difference in body depth distribution in different localities, e.g. the Lake Tsana population is modally less than the Lake Baringo and Omo river populations.

The mouth and lips exhibit a considerable degree of variation. 'Rubber-lipped' forms are common, e.g. the forms described as *Barbus degeni* (fig. 36) and *Barbus nedgia* (fig. 37). *Barbus rueppelli* (fig. 38) and *Barbus gorguarii* (fig. 39) have large mouths with the gape at 45 degrees to the horizontal ; however, *Barbus kassamensis* (fig. 40) and *Barbus hursensis* (fig. 41) link this mouth type with the ventral or subterminal mouths of the forms referred to *Barbus oreas* (fig. 42) and *Barbus erlangeri* (fig. 43). The ventral mouth with a horny lower lip is found in *Barbus macmillani* (fig. 44) and *Barbus bingeri*. Although the differences seem quite distinct when isolated examples are considered, examination of a large number of specimens shows that the mouth types grade into each other without any sharp divisions. The form of the mouth in this species is valueless as a taxonomic character.

Four barbels are invariably present ; the Lake Stephanie population has modally slightly longer barbels than any other population, but this is very possibly a reflection of the size range of the sample. The barbels are relatively smaller in larger fishes, partly because of negative allometry and partly because of the increased chance of physical damage. Histograms of the barbel length in different populations are shown in fig. 45. The head length varies considerably. The forms with

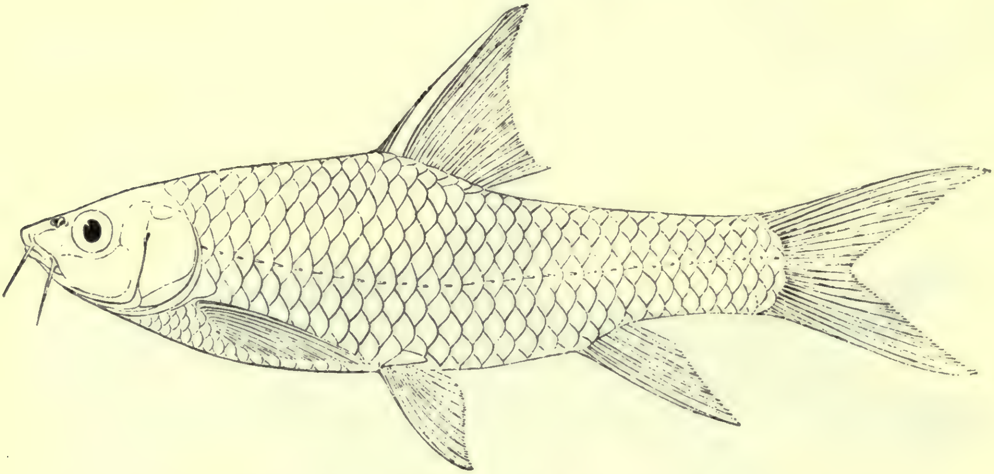


FIG. 40. *Barbus intermedius* (Holotype of *B. kassamensis* Boulenger 1911a).

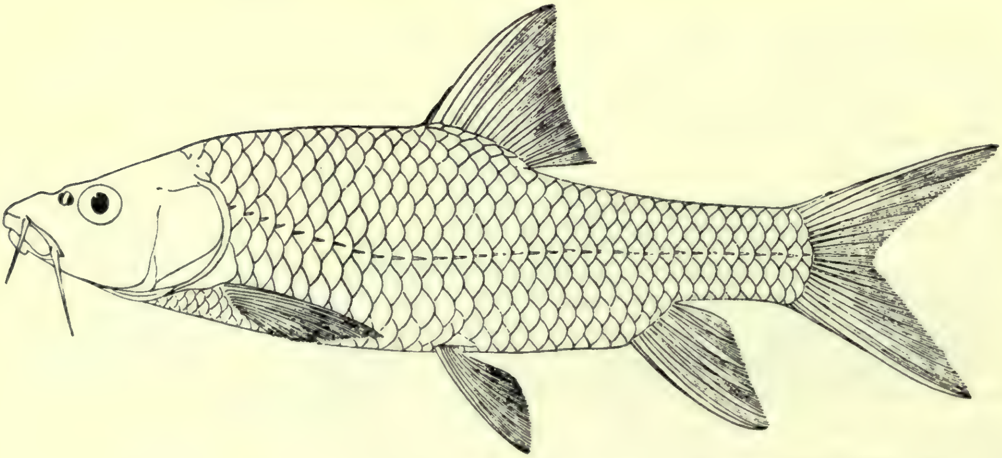


FIG. 41. *Barbus intermedius* (Holotype of *B. hursensis* from Boulenger 1911a).

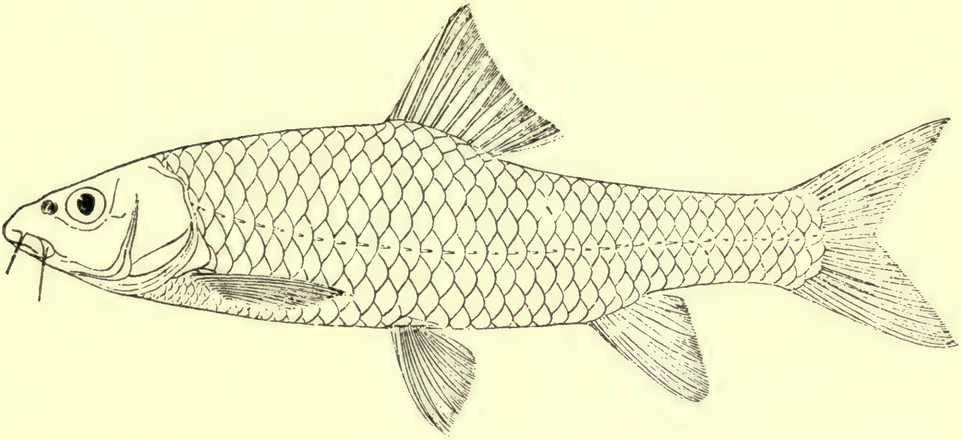


FIG. 42. *Barbus intermedius* (Holotype of *B. oreas* from Boulenger 1911a).

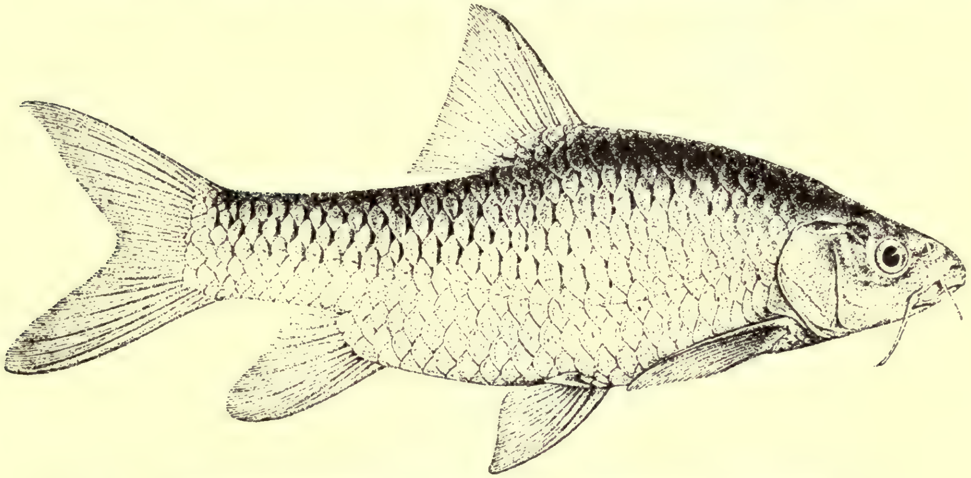


FIG. 43. *Barbus intermedius* (Holotype of *B. erlangeri* from Boulenger 1911a).

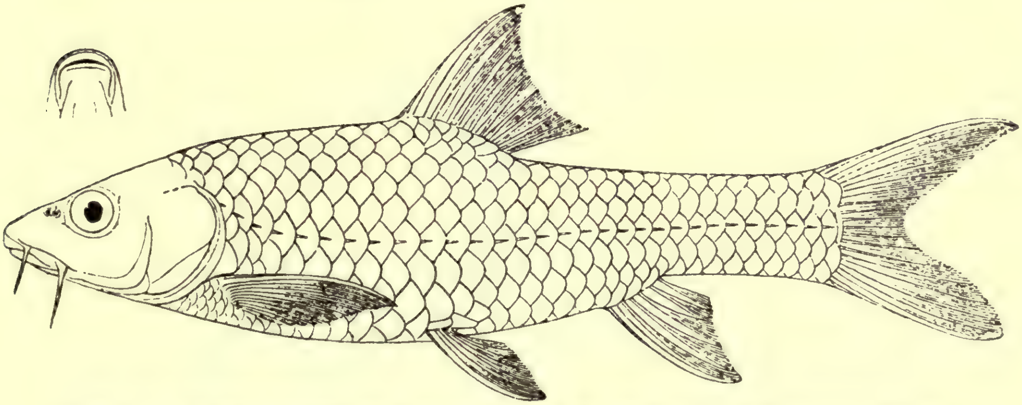
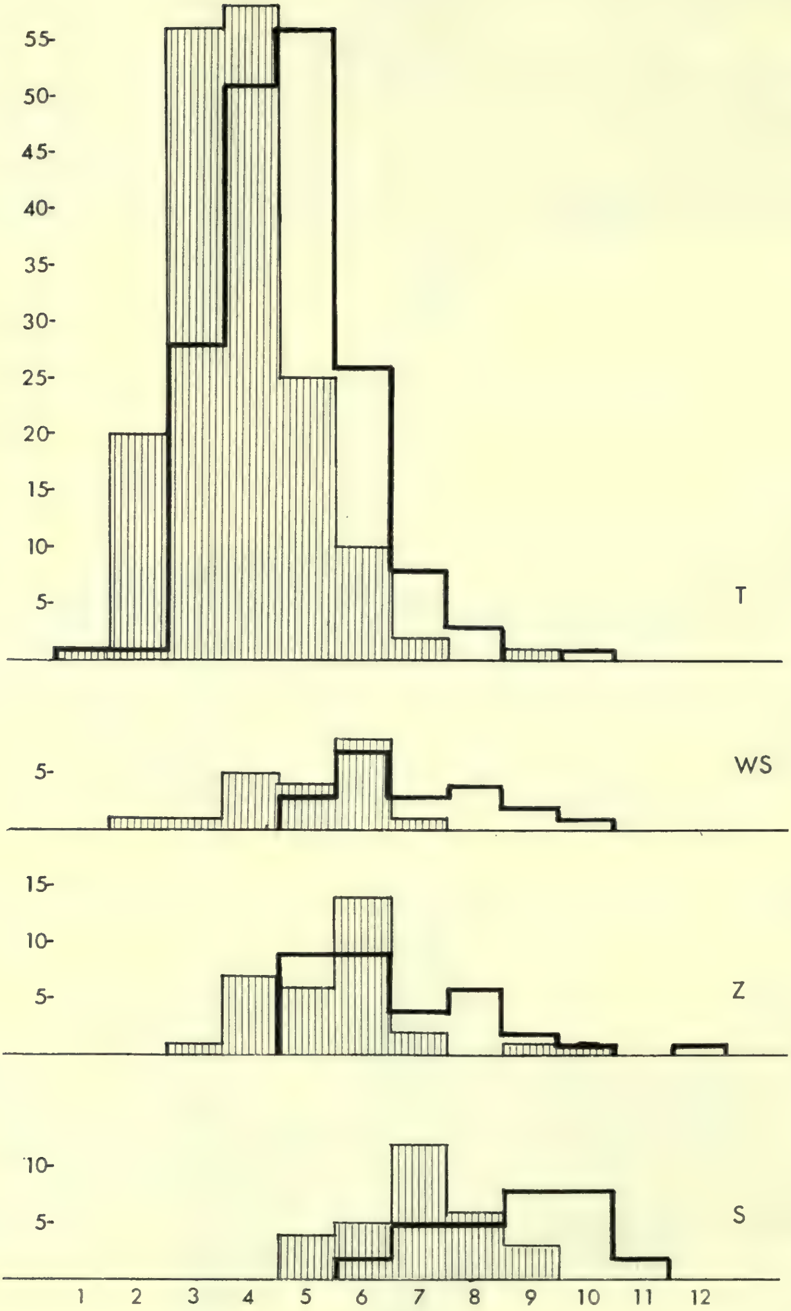


FIG. 44. *Barbus intermedius* (Holotype of *B. macmillani* from Boulenger 1911a).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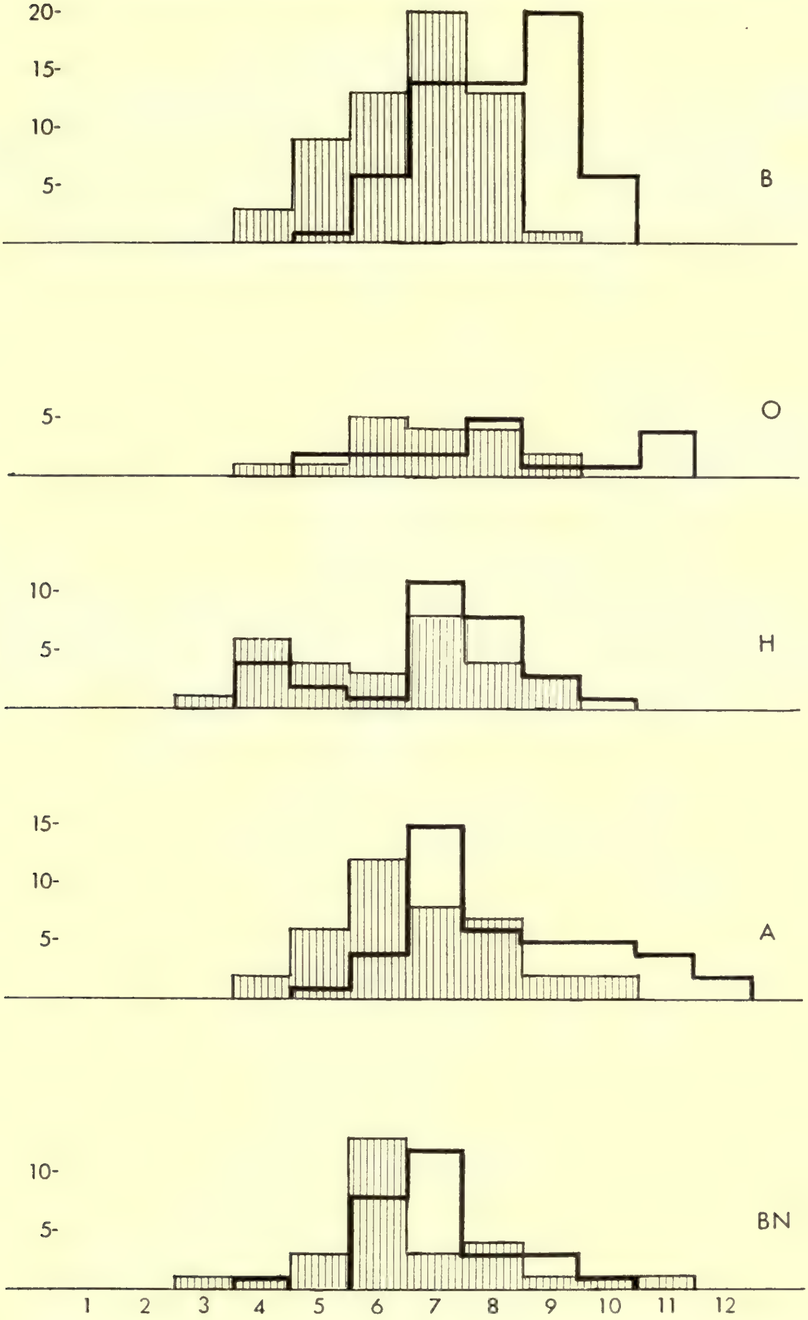

FIG. 45. Histograms of the distribution of the anterior and posterior barbel lengths in *Barbus intermedius* populations from various localities. The lengths are expressed as percentages of the standard length. The shaded column represents the anterior barbel. The locality codes are as in Fig. 34.

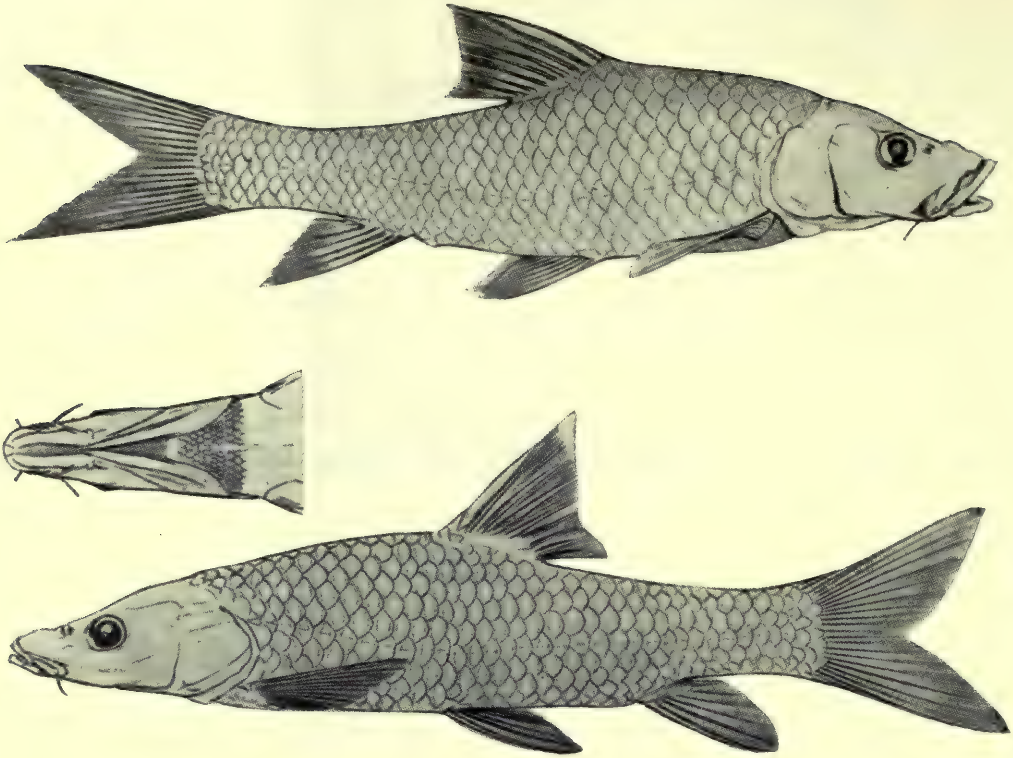

FIG. 46. *Barbus intermedius* (figured examples of *B. brunelli* (above) and *B. brunelli acutirostris* from Bini 1940).

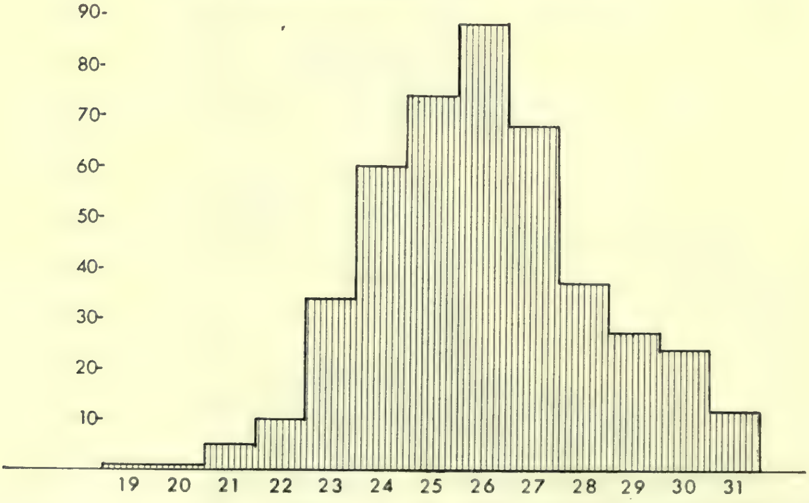

FIG. 47. Histograms of the distribution of the head length expressed as a percentage of the standard length for the entire *Barbus intermedius* sample.

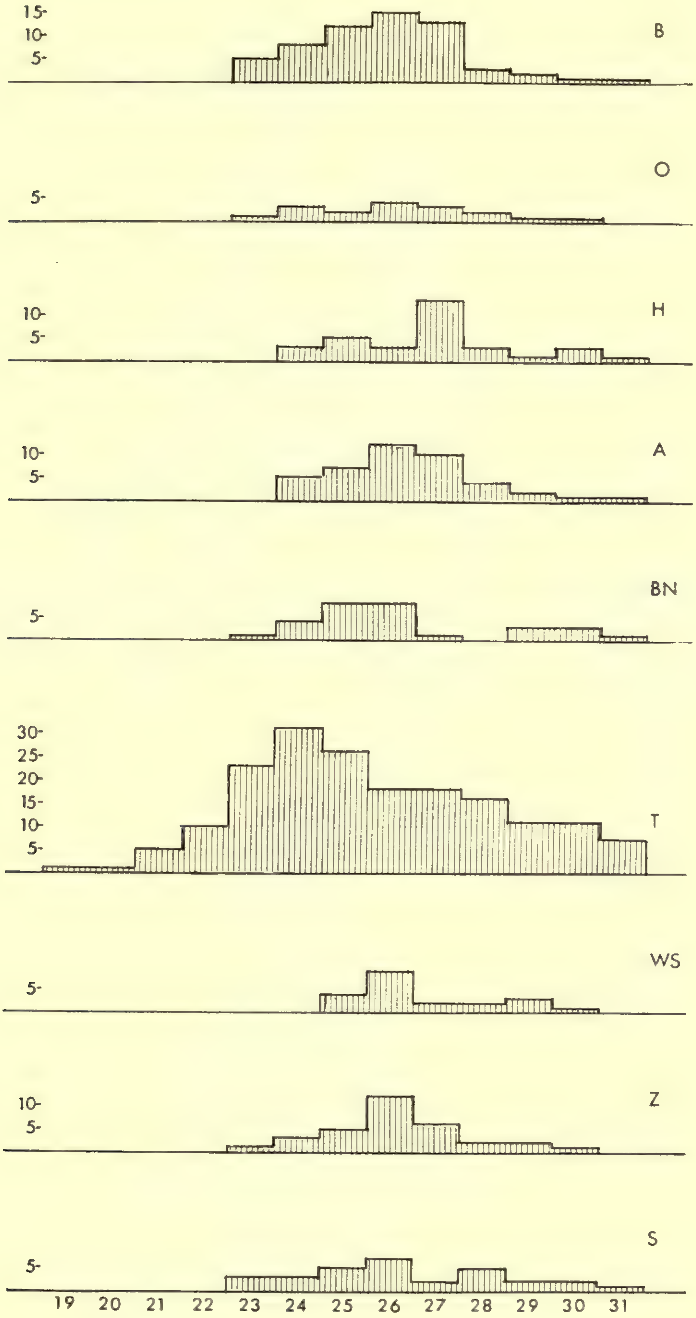

FIG. 48. Histograms of the distribution of the head length expressed as a percentage of the standard length for *B. intermedius* populations from various localities. Locality coding as in Fig. 34.

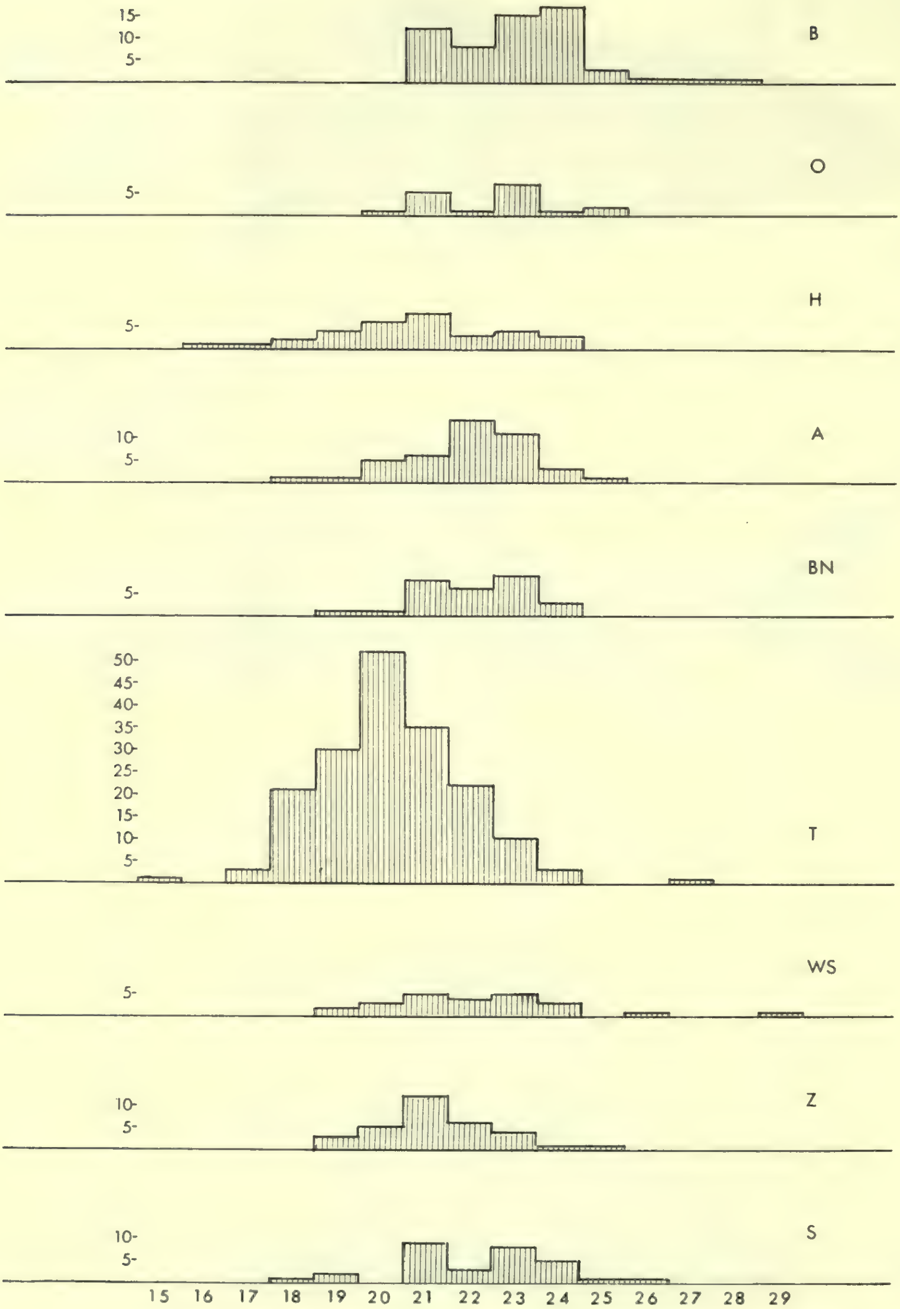

FIG. 49. Histograms of the distribution of the pectoral fin length expressed as a percentage of the standard length in populations from various localities. Locality coding as in Fig. 34.

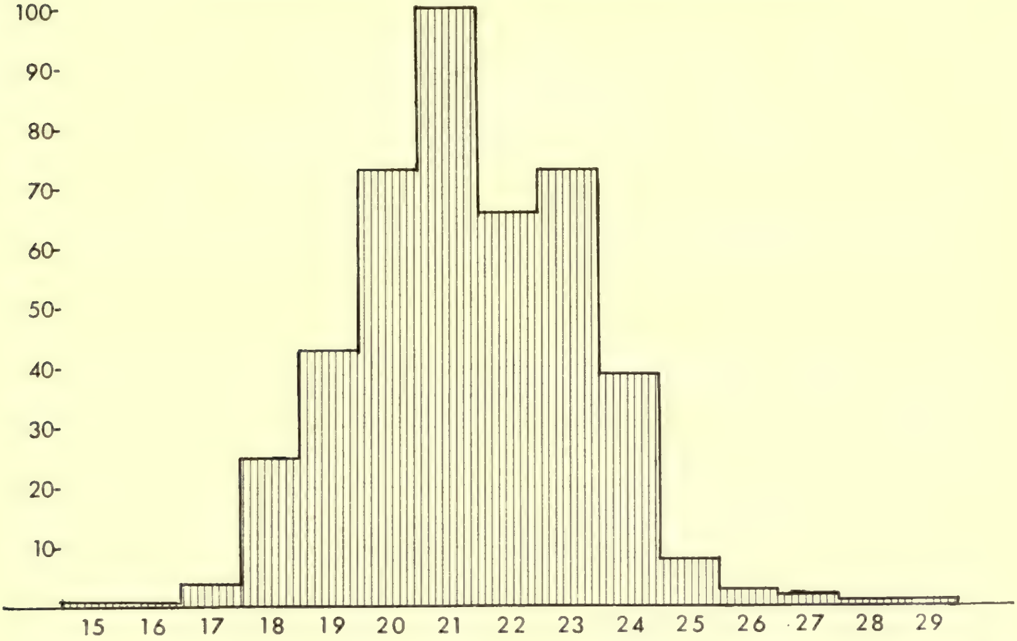

FIG. 50. Histograms of the distribution of the pectoral fin lengths for the entire sample of *B. intermedius*. Lengths are expressed as a percentage of the standard length.

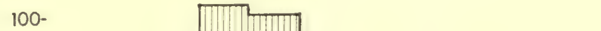

FIG. 51. Histogram of the distribution of the lateral line count for the entire sample of *Barbus intermedius*.

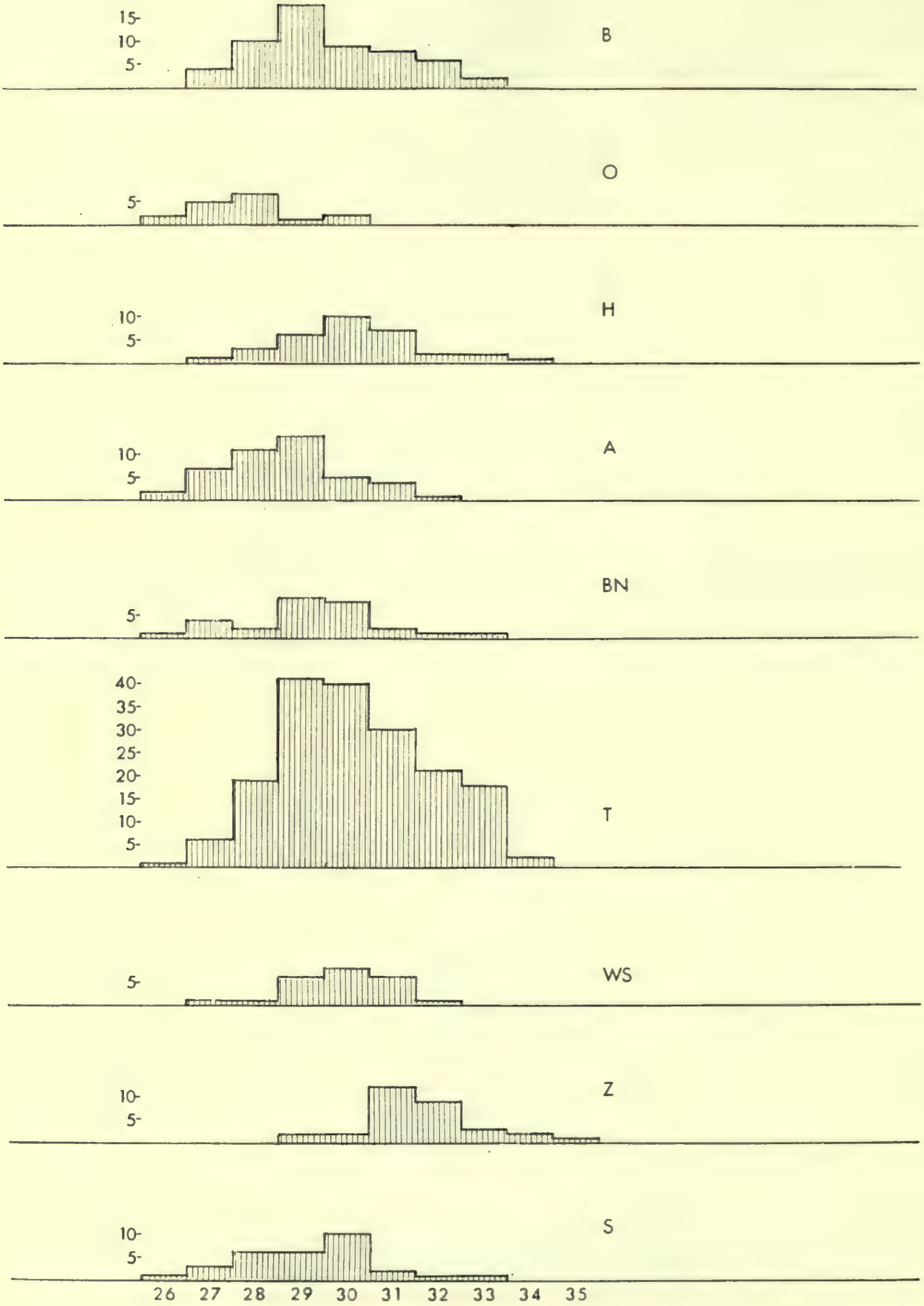

FIG. 52. Histograms of the distribution of the lateral line scale counts of *Barbus intermedius* populations from various localities. Locality coding as in Fig. 34.

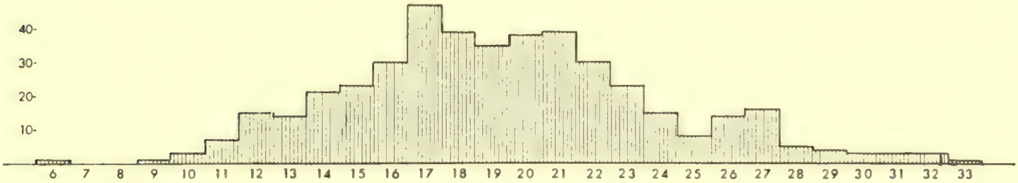

FIG. 53. Histogram of the distribution of the dorsal spine lengths, expressed as a percentage of the standard length of the entire *Barbus intermedius* sample.

the longest heads (*Barbus brunellii*, fig. 46, and *Barbus gorguarii*, fig. 39) are usually large mouthed but the correlation is not perfect. The head length distribution is normal (fig. 47) when the whole sample is considered, but the small samples from some localities, e.g. the Blue Nile, give a chance bimodal or discontinuous distribution (fig. 48). No significance can be attached to this.

The pectoral fin is modally longest in the Lake Baringo sample (fig. 48). The histogram for the entire sample (fig. 50) is bimodal, suggesting a significant difference in the Baringo fishes and these (see below) have been accorded sub-specific status.

*Squamation.* The scales bear numerous longitudinal striae. The lateral line scale count range for the whole sample is from 26 to 35 (fig. 51). The range and frequencies for each population show no significant variation (fig. 52). The lateral line count is adequate for distinguishing a *Barbus intermedius* sample from a *Barbus altianalis* sample, but is of no value for characterizing the subspecies of *Barbus intermedius*. There are almost always twelve scales around the caudal peduncle. The only exceptions are three specimens from Lake Tsana that have 13. Between the dorsal mid-line and the lateral line there are 4·5 (f.24), 5 (f.1), 5·5 (f.381), 6 (f.2), or 6·5 (f.33) scale rows. Between the lateral line and the ventral mid-line there are 4 (f.1), 4·5 (f.160), 5 (f.2), 5·5 (f.231), 6 (f.1), 6·5 (f.30) or 7·5 (f.1) scale rows. Between the lateral line and the base of the ventral fin there are 1·5 (f.2), 2 (f.9), 2·5 (f.246), 3 (f.41), 3·5 (f.137), 4 (f.1) or 4·5 (f.3) scale rows. The number of scale rows is, not infrequently, different on either side of the specimen and in many cases scales had been lost and it was impossible to count the original number.

Zolezzi (1940) gives 39–40 scales in the lateral line series of *Barbus platystomus* var. *vatovae*. The only specimen in the collections of the Stazione Idrobiologia, Roma (where Zolezzi's specimens were lodged), that is attributed to this variety and is of the same length as Zolezzi's holotype has only 30 lateral line scales on one side and 31 on the other. This specimen is not labelled as type material but agrees with the only specimen described by Zolezzi in all respects except for the lateral line scale count.

*Dorsal fin.* The origin of the dorsal fin varies from just in front to just behind the vertical to the origin of the pelvic fins.

There are four unbranched rays. The last of these is ossified into a smooth spine, $\bar{x}$ = 20·1, s.d. = 4·9, s.e. = 0·2, range 6·9–33·9 (percentage of the S.L.). The range is unusually large and reflects the size range of the specimens examined and

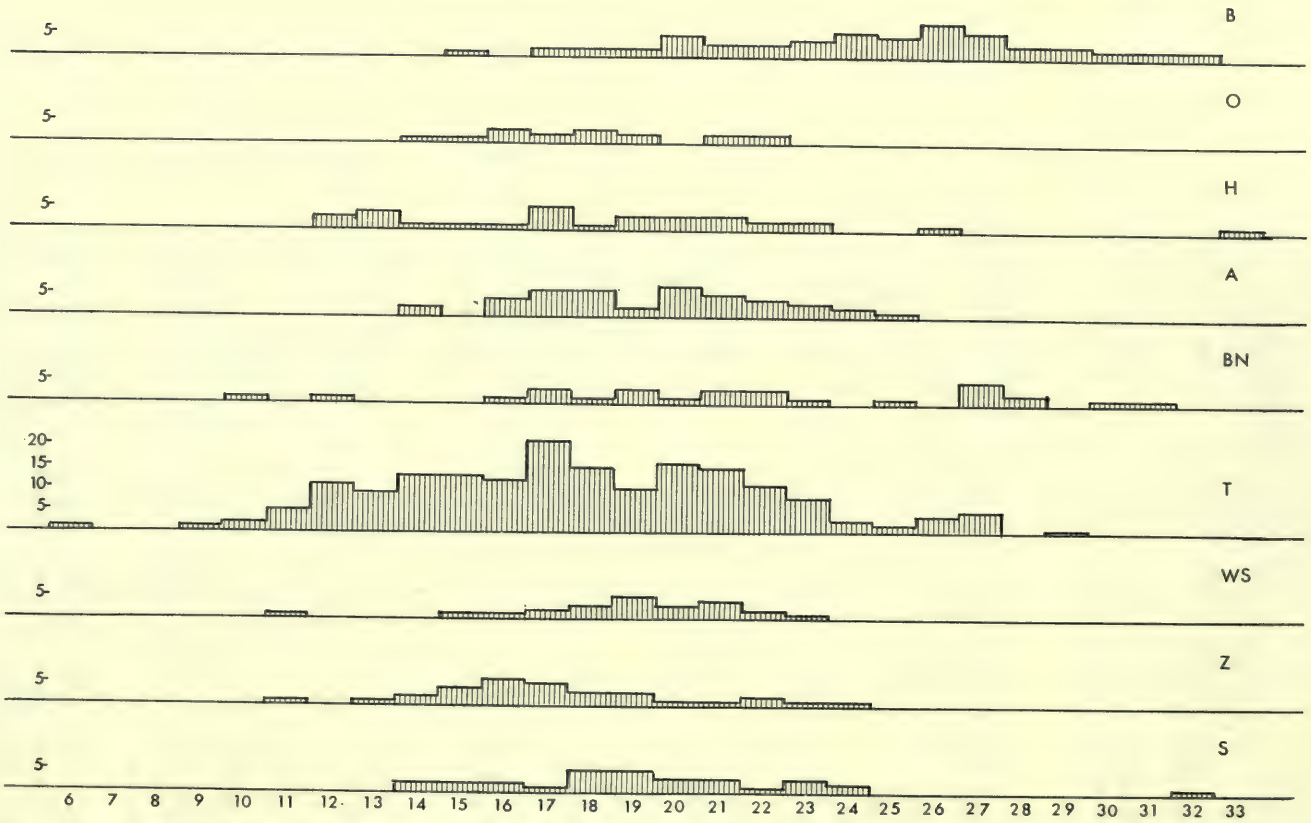

FIG. 54. Histograms of the distribution of the dorsal spine lengths of *Barbus intermedius* populations. Lengths are expressed as a percentage of the standard length. Locality coding as in Fig. 34.

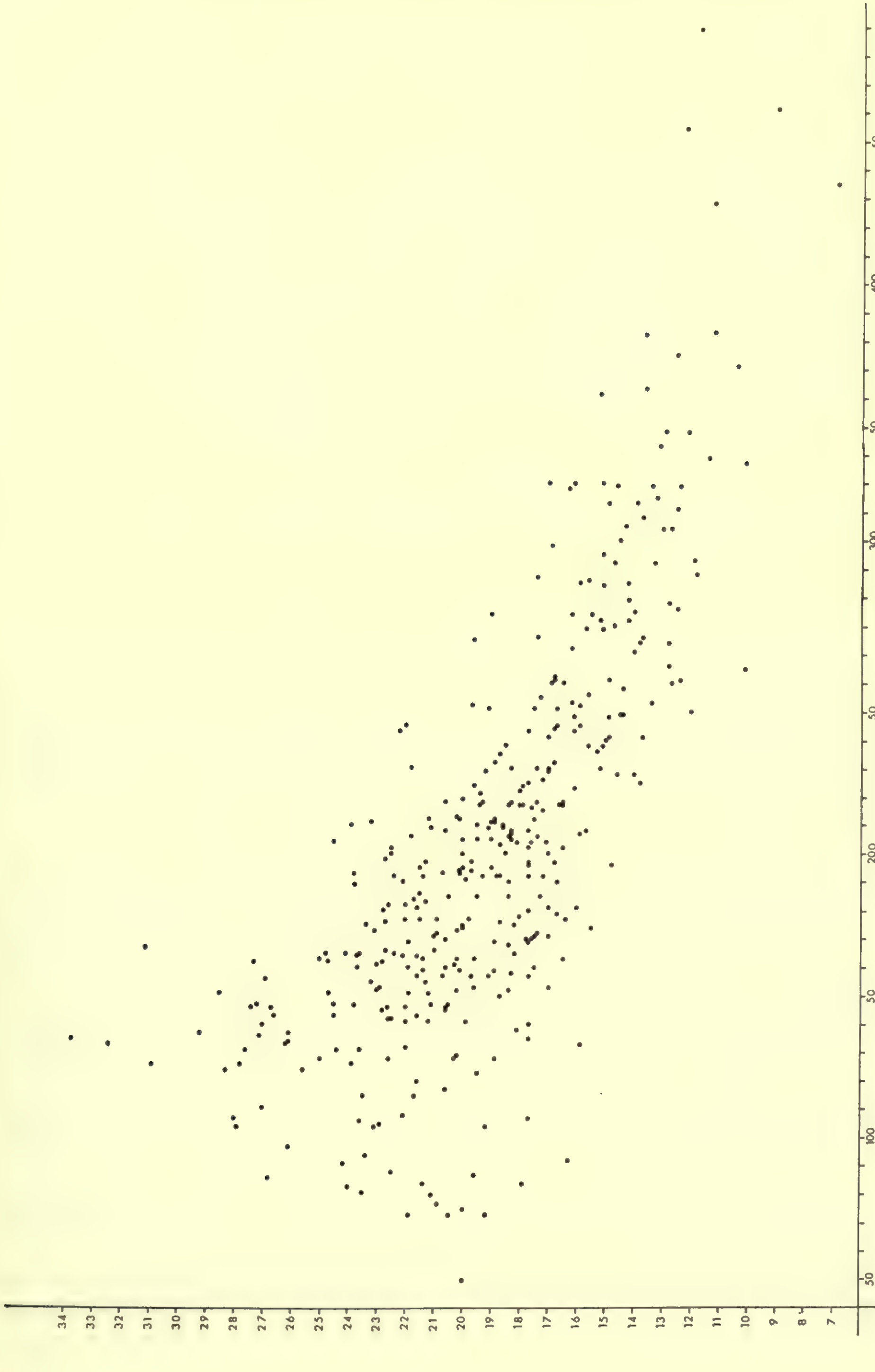

FIG. 55. Scatter diagram of the dorsal spine length as a percentage of the standard length against the standard length for the entire sample of *Barbus intermedius*.

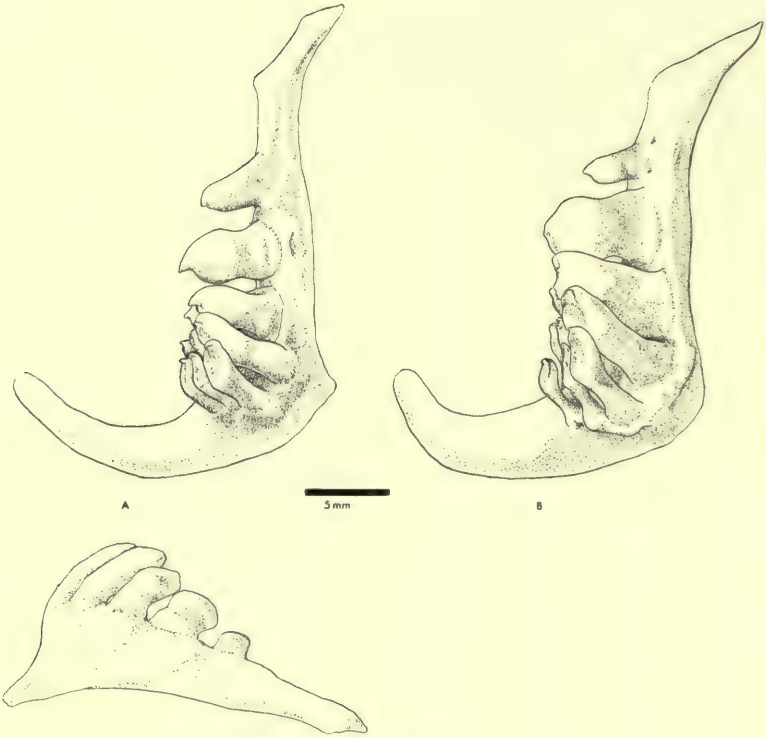

FIG. 56. A comparison of the left pharyngeal bones from a shallow-bodied specimen of, A, *B. intermedius* (previously identified as *B. gorguarii*) of 329 mm S.L. with a deep-bodied specimen, B, (previously identified as *B. macronema*) of 332 mm S.L.

the negative allometry of the dorsal fin spine (see below). A histogram of the distribution of the length of the dorsal fin spine (fig. 53) shows that the whole sample is bimodal. The fishes with the relatively longer spines all came from Lake Baringo (fig. 54). The length of the spine serves as one of the distinguishing characters of this population (see above). Without the Lake Baringo fishes the dorsal spine has a mean length of 19·1 and the same range as in the whole sample (6·9–33·9). These values cover too wide a range to be useful as a diagnostic character. A graph of the dorsal spine length (expressed as a percentage of the S.L.) against the standard length (fig. 55) shows that the spines are relatively shorter in longer fishes. For fish of less than 170 mm S.L. the dorsal spine values are $\bar{x}$ = 22·6; s.d. = 3·4; s.e. = 0·3; range 16·3–33·7; for fishes of 171–250 mm S.L., $\bar{x}$ = 18·9; s.d. = 2·3; s.e. = 0·2; range 13·8–24·5; for fishes of more than 251 mm S.L., $\bar{x}$ = 14·2; s.d. = 2·4; s.e. = 0·2; range = 6·9–19·7.

Almost the same number of specimens have eight branched dorsal fin rays as have nine. No other number was observed except in cases which were obviously the result of physical damage.

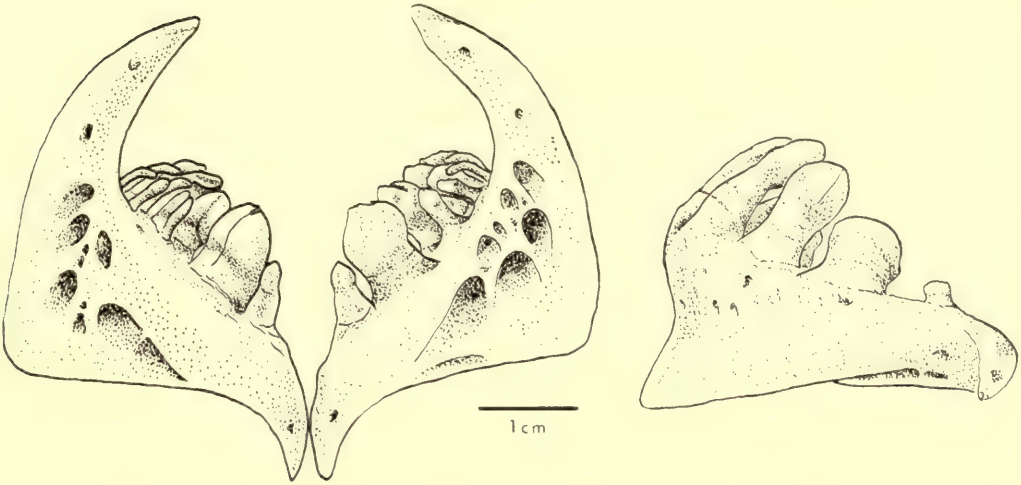

FIG. 57. The pharyngeal bones from a specimen of *Barbus intermedius* (previously identified as *B. surkis*) of 348 mm S.L.

The *anal fin* invariably has three unbranched rays and five branched rays.

The *gill raker* count was only taken on 47 specimens. The range is from 10 to 16 on the lower arm of the first gill arch. The only factor which might have some significance is that the long-headed fishes tend to have 10–12 gill rakers whilst the shorter-headed fishes have 12–16 gill rakers. Not enough specimens were examined to attribute any real significance to this difference.

*Pharyngeal bones and teeth.* The pharyngeal bones vary in shape. Generally at an equal S.L. fishes with a proportionately longer head have thinner pharyngeal bones than shorter-headed specimens ; fig. 56 contrasts the pharyngeals of a specimen of the '*gorguarii*' form, a fish of 329 mm S.L., with the pharyngeals of a specimen of the '*macronema*' form of 323 mm S.L.

An even greater difference is immediately noticeable in the deep-bodied specimens ; fig. 57 shows the pharyngeals from a specimen of the '*surkis*' form of 348 mm S.L. The bone in this case is extremely thick and the teeth are molariform. A radiograph of this specimen [B.M. (N.H.) No. 1902.12.13 : 229] shows its stomach to be full of gastropod mollusc shells. Possibly the difference in pharyngeal bone strength reflects differences in diet and age. The left pharyngeal bone of a slender-bodied *Barbus brunellii* is shown in fig. 58.

The pharyngeal teeth number, without exception, 2.3.5.–5.3.2. In fishes < 180–200 mm S.L., the teeth are long with recurved, mammilliform crowns (as shown in fig. 58) whilst larger and bulkier fishes have teeth like those shown in fig. 57. Needless to say these examples are linked by an almost continuous series of intermediate shapes. I am unable to offer anything more than the most tentative elucidation of this variation (see p. 127).

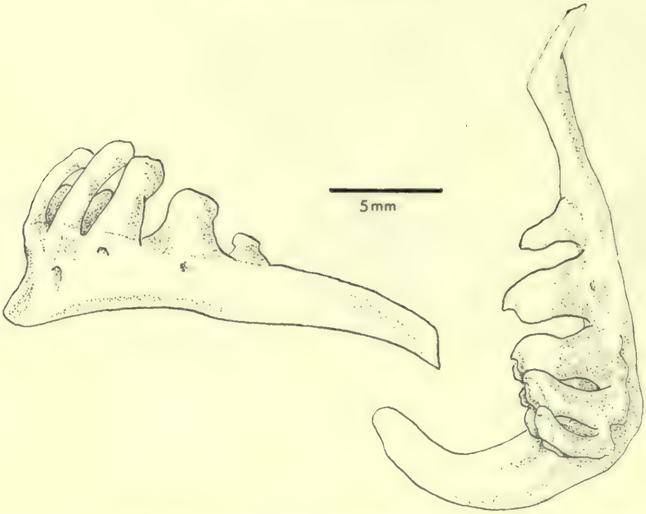

FIG. 58. Pharyngeal bones from a specimen of *Barbus intermedius* (one of Bini's *B. brunellii*).

Little is known about the effect of age and diet upon cyprinid pharyngeal teeth. The range in pharyngeal tooth form shown by *Barbus intermedius* is paralleled to some extent by that in *Barbus altianalis* where the deep-bodied form hitherto referred to *Barbus obesus* possesses singularly massive pharyngeal bones (see p. 14).

*Coloration.* This is very variable. In life the body colour ranges from silvery-grey to blue, through green, olive and brown, to bronze. Some specimens have been reported with pinkish or yellowish bellies. The fins have been described as whitish tinged with crimson, deep-green, slaty-grey, yellowish and yellow-green. It is quite possible that the colour may be a constant difference distinguishing populations, but there is not enough information available at the moment. In alcohol-preserved specimens the body is grey, brown or bronzy, the scales are usually darker at the base and the fins more or less the colour of the body.

DISTRIBUTION. *Barbus intermedius* is widely distributed throughout Southern Ethiopia and into Northern Kenya, certainly as far as Lake Baringo (fig. 60). It has been recorded from the following rivers: Omo system – Zendo, Gibe, Wondinak and Ergino rivers; Webi Shebeli system – Errer, Jerrer, Iraro and Modjo rivers; Hawash system – Kassam, Hurso, Akaki and Gota rivers; Blue Nile system – Wama, Urgessa, Gudar, Metti, Juju, Didessa and Mogre rivers; Euasso Nyiro system – Uaso Narok; Juba system – Awata river; Lake Zwai basin – Suksuki and Maki rivers; Lakes Abaya and Ganjule basins – Zeissi, Sire, Ganda, Elgo, Alaba and Burka rivers; Lake Stephanie basin – Zuja, Sagan, Gato and Barja rivers; Lake Rudolf basin – Kerio and Ngeng rivers. It has also been recorded from Lakes Zwai, Tsana, Baringo, Langano, Abaya, Ganjule, Orsodi and Stephanie.

There has been a certain amount of confusion over the presence of *Barbus gregorii* (= *Barbus intermedius australis*) in the Athi-Tana system as Mann (1971) noted.

The localities for the syntypes are given by Boulenger (1911a) as: 1 Kiroruma (Upper Tana), Leikipia; 2–4, Guasso el Narua (Baringo), Leikipia; 5–6, Guasso Nyuki (Naiwasha), Njemps Ndogo and a skeleton, 7, Kibwesi river (Athi). All of these specimens were collected by Professor J. W. Gregory's expedition. Mann (*ibid.*) was unable to trace these localities with any certainty, but he points out that the Leikipia plateau drains into the northern Euasso Nyiro and Lake Baringo, not into the Tana system. Gregory (1896) in his account of his travels gives grid references for Guasso Nyuki and Guasso el Narua. The former is a small stream at 0°28′ N, 36°08′ E, slightly east of south of Lake Baringo, the latter is at the foot of the Leikipia escarpment, to the east of Lake Hannington at 0°16′ N, 38°18′ E. Guasso Nyuki is nowhere near Lake Naivasha. The map of Gregory's route crosses these rivers at the grid references given. The problem of Kiroruma is not so easily

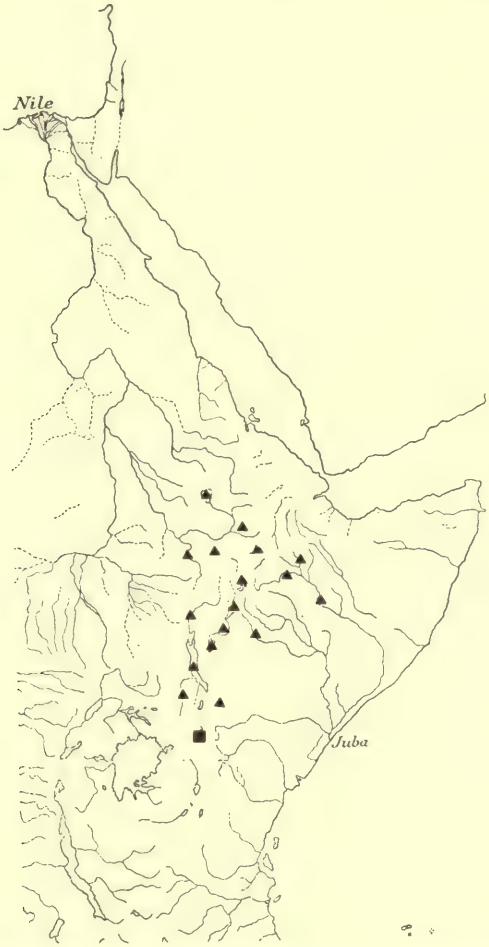

FIG. 59. The distribution of *B. intermedius*: ▲ = *B. intermedius intermedius*, ■ = *B. intermedius australis*.

settled. Mann (*ibid.*) says that it is not on any modern maps. Gregory's (*loc. cit.*) gazetteer gives the following information ; Kiroruma = Kiloluma 0°40′ S, 37°30′ E. The river is marked on his map and is in the upper Tana system, parallel to the Thika-Thika river, Gregory's route did not pass through that grid reference (according to his route map) and at the nearest was 24 km away from his location of the Kiroruma river. From Gregory's text (1896 : 199) it appears that he was in a great hurry at the time that he was in this area and there is no mention of specimens having been collected. The Kiroruma is separated from the Leikipia escarpment and plateau by Mount Kenya and no specimens of *Barbus intermedius* (*sensu lato*) have been collected from neighbouring rivers in the Tana system (but see below). At the moment this matter cannot be resolved.

Specimen No. 7 of *Barbus gregorii* in Boulenger (1911a : 46) from Kibwesi is another problem. It bears the B.M. (N.H.) Reg. No. 1893.12.2 : 36. This number, according to the register, is one of 16 specimens of *Barbus tanensis* (= *Barbus oxyrhynchus*) brought back by the Gregory expedition. *Barbus intermedius* and *Barbus tanensis* were the only *Barbus* spp. brought back by the expedition and they are easy to distinguish, especially so as the specimens are large. The other five specimens bearing the locality Kibwesi are undoubtedly *Barbus tanensis*. This is inexplicable. Three of Gregory's specimens of *Barbus tanensis* were recorded as having come from Guasso el Narua (see above). This species has not been found there since and I am at a loss to explain its alleged presence there. Perhaps the locality was incorrectly recorded, there are enough inconsistencies in this collection to cast a shadow of doubt over some of the localities. The Lake Baringo basin is the most southerly definitive record of *Barbus intermedius*, but further south in the rift valley before the Aberdare mountains and the Maui (or Mau) escarpment lie Lakes Hannington, Elementaita, Nakuru and Naivasha. The first three of these are extremely alkaline. Lake Naivasha according to Worthington (1932b, 1933) and Copley (1948) has a small, cyprinodont, *Aplocheilichthys antinorii*, as its only indigenous fish, but *Tilapia nigra* was introduced in 1925 and *Micropterus salmoides* was introduced later. Copley (1948) mentions that no *Barbus* species are present in Lake Naivasha but Parenzan (1939) lists *Barbus gregorii* (= *Barbus intermedius*) as present in the lake. Whether this locality of Parenzan's was based on first-hand evidence or taken from Boulenger's (1911a) list I cannot find out.

The significance of *Aplocheilichthys antinorii* is that it also lives in Southern Ethiopia, i.e. the distribution is similar to that of *Barbus intermedius*. Cooke (1958), in his reconstructions of the lower Pliocene drainage of east Africa, shows volcanic highlands present in the Aberdare region (to the immediate south of Lake Naivasha) and the 'Nile' and 'Athi–Tana' drainage areas much as they are today. This ancient separation of the two watersheds largely precludes the presence of many species in common.

The northern Euasso Nyiro river presents certain problems, not the least of which is the paucity of specimens. From this river in the region of Chanlers Falls come the three *Barbus erlangeri* (= *Barbus intermedius*) specimens whilst from the eastern extremity of the system in the Nero–Narok and Ngau–Narok systems associated with the Lorian swamp come 17 specimens of *Barbus oxyrhynchus*. The presence of

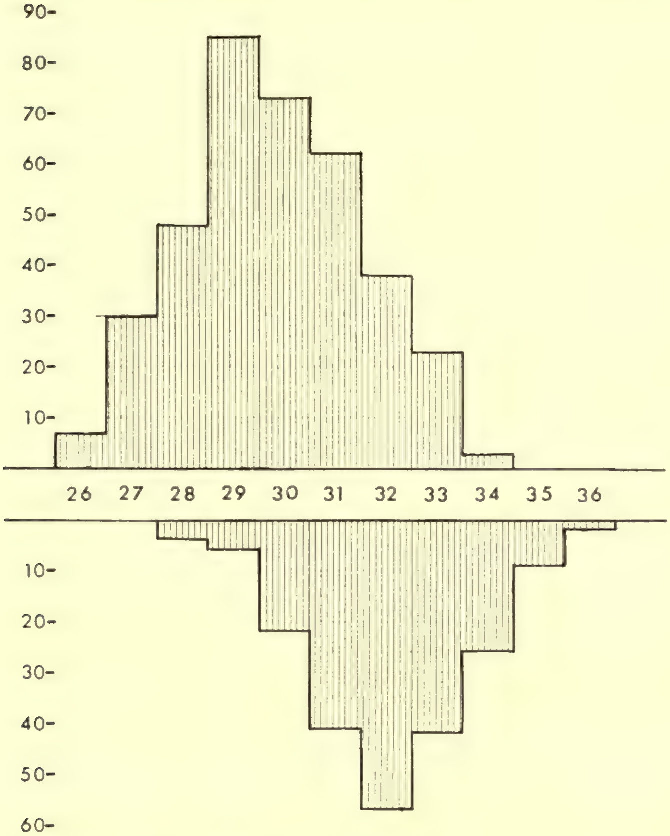

FIG. 60. Histograms comparing the distribution of the lateral line counts of *Barbus intermedius* (above) with *B. altianalis* (below).

'Nilotic' and an 'Athi–Tanan' species in the same river system is surprising, but the watersheds across the divide are low. This area is now semi-desert, but about the time that Lake Baringo was connected to Lake Rudolf the water table must have been much higher and water connections must have linked the two river systems in this region.

The subsequent drop of water level has left the Euasso Nyiro system as a relict area containing examples of the formerly contiguous faunae.

DIAGNOSIS AND AFFINITIES. *Barbus intermedius* is a variable species and bears a close gross morphological resemblance to *Barbus altianalis*, to which I suggest it is very closely related. These two species (and *Barbus acuticeps* and *Barbus ruasae*) form a group of closely related species referred to here as the *intermedius* group or complex.

Typically *Barbus intermedius* has a shallow compressed body, a caudal peduncle longer than it is deep, numerous more or less parallel striae on the scales and a well-ossified dorsal spine of moderate length and stoutness.

It is difficult to distinguish a specimen of *Barbus altianalis* from *Barbus intermedius* if the locality is unknown. There are modal differences in the populations which are listed under *Barbus altianalis.*

Both species are polytypic and can show considerable variation, particularly in body shape and mouth form. However, it has always proved possible to distinguish an unusually deep-bodied member of the *Barbus intermedius* group from a member of the typically deep-bodied *Barbus bynni* group because members of the latter group have more compressed bodies and longer, stronger dorsal spines.

*Barbus intermedius* is not, as far as I know, found in the same localities as *Barbus altianalis.* The nearest approach of these two species appears to be in the poorly collected Karasuk area to the north-east of Lakes Victoria and Kioga where the headwaters of the Lake Rudolf basin streams and the Lake Victoria and Kioga basin streams are very close.

The *intermedius* complex is discussed further on p. 128. The two subspecies of *Barbus intermedius* can be distinguished, not only by locality, but also by the modally much longer dorsal spine of *Barbus intermedius australis* ($\bar{x}$ = 24·9 against 19·1 in *Barbus intermedius intermedius*). *Barbus intermedius australis* also has a longer pectoral fin ($\bar{x}$ = 23·4 against 21·5) and longer barbels (Ab, $\bar{x}$ = 7·1 against 5·6 ; Pb, $\bar{x}$ = 8·4 against 6·7). Regrettably it is not always possible to place an individual specimen, lacking locality data, in the correct group.

### ***Barbus intermedius intermedius*** Rüppell

A general description is given on p. 51. Them orphometric data for this subspecies are :

| | n | $\bar{x}$ | s.d. | s.e. | range |
|---|---|---|---|---|---|
| D | 388 | 28·1 | 2·8 | 0·1 | 20·7–37·7 |
| H | 388 | 26·5 | 2·3 | 0·1 | 19·0–31·7 |
| I | 388 | 6·0 | 1·4 | 0·1 | 3·5–10·2 |
| IO | 388 | 8·0 | 0·9 | 0·04 | 4·7–11·6 |
| MW | 386 | 5·9 | 1·0 | 0·05 | 3·6– 9·1 |
| Pct | 388 | 21·5 | 2·0 | 0·1 | 15·6–29·0 |
| CPl | 388 | 17·0 | 1·6 | 0·1 | 11·7–22·9 |
| CPd | 388 | 11·5 | 1·2 | 0·1 | 8·6–15·0 |
| Snt | 388 | 8·6 | 1·2 | 0·05 | 5·4–12·7 |
| Ab | 385 | 5·6 | 1·8 | 0·1 | 1·8–11·1 |
| Pb | 387 | 6·7 | 2·1 | 0·1 | 1·9–12·1 |
| DSp | 385 | 19·1 | 4·2 | 0·2 | 6·9–33·9 |

Not all specimens examined are included in the morphometric data above.

The size range of the specimens is 94 to 489 mm S.L. The lateral line count ranges from 26 to 34; 26 (f.7), 27 (f.27), 28 (f.49), 29 (f.85), 30 (f.85), 31 (f.63), 32 (f.36), 33 (f.25), 34 (f.5).

Between the dorsal mid-line and the lateral line there are 4·5 (f.24), 5 (f.1), 5·5 (f.325), 6 (f.2) or 6·5 (f.32) scale rows. Between the lateral line and the ventral mid-line there are 4 (f.1), 4·5 (f.109), 5 (f.2), 5·5 (f.226), 6 (f.1), 6·5 (f.29) or 7·5 (f.1) scale rows. Between the lateral line and the base of the ventral fin there are 1·5 (f.2), 2 (f.9), 2·5 (f.242), 3 (f.40), 3·5 (f.85), 4 (f.1) or 4·5 (f.3) scale rows.

DISTRIBUTION. The distribution is as on p. 70 except for Lake Baringo.

### *Barbus intermedius australis* ssp. nov.

HOLOTYPE. A fish of 128 mm S.L., No. 18 in 1932.6.13 : 191–200, from a jar labelled *Barbus gregorii*, Lake Baringo, in the collection of the B.M. (N.H.). This specimen was selected as being close to the mean for most morphometric characters, and therefore is typical of the population.

DESCRIPTION. The description is largely as for the nominate subspecies (see p. 51). The morphometric data in detail are as follows and based on 58 specimens, S.L. 66–388 mm.

| | n | x̄ | s.d. | s.e. | range |
|---|---|---|---|---|---|
| L | | | | | 66 –388 mm |
| D | 58 | 30.0 | 2·2 | 0·3 | 26·3–35·1 |
| H | 58 | 26·2 | 1·7 | 0·2 | 23·0–31·0 |
| I | 58 | 6·0 | 1·0 | 0·1 | 4·4– 9·1 |
| IO | 58 | 8·1 | 1·0 | 0·1 | 6·1–12·3 |
| MW | 58 | 5·5 | 0·7 | 0·1 | 4·1– 7·3 |
| Pct | 58 | 23·4 | 1·5 | 0·2 | 21·0–27·2 |
| CPl | 58 | 16·1 | 1·4 | 0·2 | 11·7–18·7 |
| CPd | 58 | 12·7 | 0·9 | 0·1 | 9·5–14·2 |
| Snt | 58 | 8·4 | 0·9 | 0·1 | 6·7–10·7 |
| Ab | 58 | 7·1 | 1·2 | 0·2 | 4·8–10·0 |
| Pb | 58 | 8·4 | 1·3 | 0·2 | 6·0–10·9 |
| DSp | 58 | 24·9 | 3·9 | 0·5 | 15·6–32·3 |

The number of scales in the lateral line ranges from 27 to 33 : 27 (f.4), 28 (f.11), 29 (f.18), 30 (f.9), 31 (f.8), 32 (f.6), 33 (f.2). Only one specimen has 6·5 scale rows between the dorsal mid-line and the lateral line, the rest have 5·5. Between the lateral line and the ventral mid-line there are 4·5 (f.51), 5·5 (f.4), or 6·5 (f.1) scale rows. Between the lateral line and the base of the pelvic fin there are 2·5 (f.4), 3 (f.1), or 3·5 (f.52) scale rows.

The distinguishing characters of the two subspecies are the longer dorsal spine, longer pectoral fins, slightly deeper body and longer barbels in *Barbus intermedius australis*.

Lake Baringo is an alkaline lake, and it is impossible to say whether the Baringo population displays its particular phenotype as a result of the environment or as a result of the genotype. There are very slight indications that the fishes from the Omo river and Lake Rudolf incline slightly towards the Baringo facies but it must be remembered that the Lake Rudolf and Omo river sample is extremely small.

DISTRIBUTION. This species is known from Lake Baringo, Kenya.

### ***Barbus longifilis*** Pellegrin 1935

*Barbus altianalis* var. *longifilis* Pellegrin, 1935, *Revue Zool. Bot. afr.* **27** (3) : 376–385 (part, not the specimen from Nyabarongo).

NOTES ON THE DETERMINATION. This species, from the upper reaches of the Luhoho Congo, is not a variety of *Barbus altianalis,* but a well-defined species. One of Pellegrin's type series (M.H.N.P. No. 35-75) is better referred to *Barbus paucisquamatus.* Poll (1939 : 69) synonymized *Barbus altianalis* var. *longifilis* with *Barbus altianalis* var. *paucisquamata,* a move which does not take into account the much longer dorsal spine, the much longer barbels and the much deeper body of the former variety.

LECTOTYPE. A fish of 173 mm S.L. (M.H.N.P. No. 35-150). This is the least-damaged specimen of Pellegrin's type series from the Loama river.

DESCRIPTION. The description is based on nine specimens, 132–247 mm S.L.

| | x̄ | s.d. | s.e. | range |
|---|---|---|---|---|
| D | 31·2 | 1·6 | 0·5 | 29·2–34·0 |
| H | 24·6 | 0·7 | 0·2 | 23·5–25·3 |
| I | 6·5 | 0·5 | 0·1 | 6·0– 7·2 |
| IO | 8·0 | 0·5 | 0·2 | 7·0– 8·6 |
| MW | 5·5 | 0·6 | 0·2 | 4·5– 6·3 |
| Pct | 23·1 | 1·0 | 0·3 | 21·7–24·2 |
| CPl | 17·0 | 1·0 | 0·3 | 15·8–18·3 |
| CPd | 11·4 | 0·7 | 0·2 | 9·9–12·1 |
| Snt | 8·3 | 0·6 | 0·2 | 7·5– 9·3 |
| Ab | 8·9 | 0·7 | 0·2 | 8·3– 9·6 |
| Pb | 11·3 | 1·1 | 0·4 | 9·5–13·4 |

*Barbus longifilis* has a pointed snout. Except for a slight nuchal hump the dorsal profile is straight from the snout to the origin of the dorsal fin. The mouth is ventral with thin fleshy lips ; the barbels are characteristically long.

*Dorsal fin.* Has IV–9 (f.8) or IV–10 (f.1) rays, the last unbranched ray is solidly ossified into a thick straight spine (x̄ = 25·6, s.d. = 2·7, s.e. = 1·0, range 22·0–30·3). The dorsal fin origin is usually in front of the insertion of the pelvic fins. A low sheath of large scales surrounds the base of the dorsal fin.

The *anal fin* has three unbranched and five branched rays.

*Squamation.* The striae on the scales are slightly irregular, either parallel or slightly converging, the lateral line has 25 (f.1), 26 (f.3), 27 (f.3) or 28 (f.2) scales. There are 4·5 scales between the dorsal mid-line and the lateral line and 5·5 between the lateral line and the ventral mid-line. There are 2·5 (f.7) or 3 (f.2) scale rows between the lateral line and the base of the pelvic fins and without exception 12 scales are present around the caudal peduncle.

There are between 10 and 12 *gill rakers* on the lower arm of the first gill arch in the specimens examined.

*Pharyngeal bones and teeth.* The pharyngeal tooth formula is 2.3.5.–5.3.2. The first tooth in the inner row (fig. 62) is conical and directed posteriorly, the second

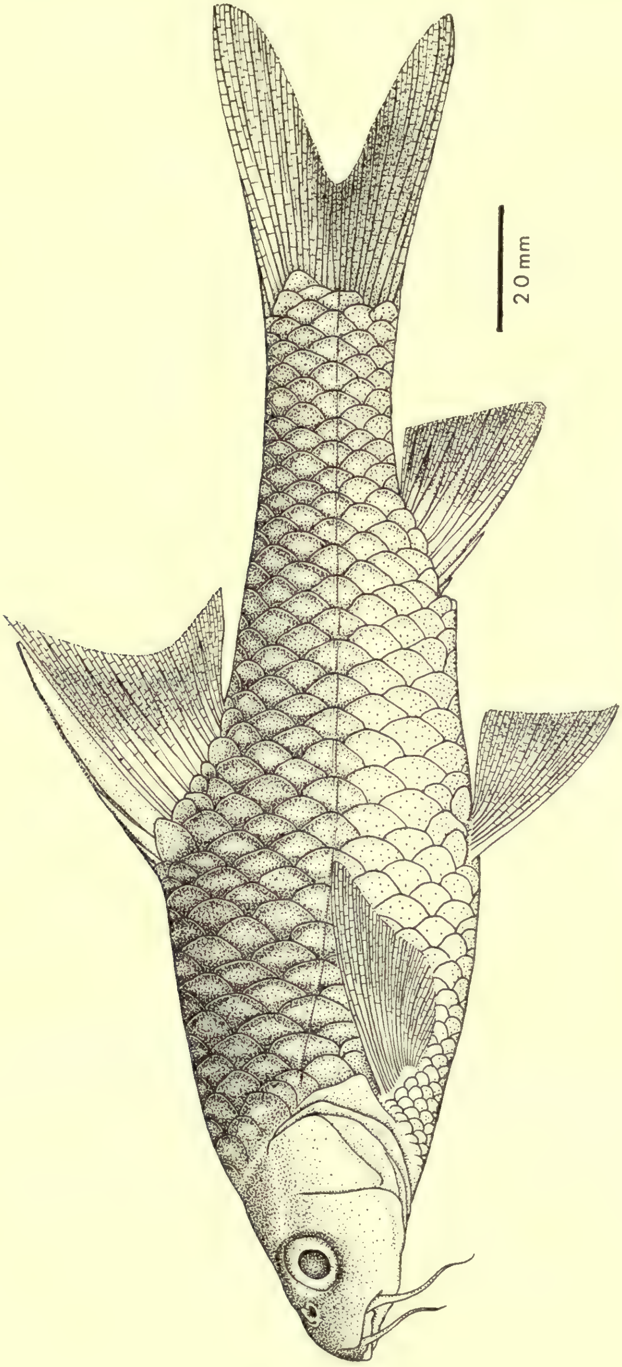

Fig. 61. *Barbus longifilis* lectotype.

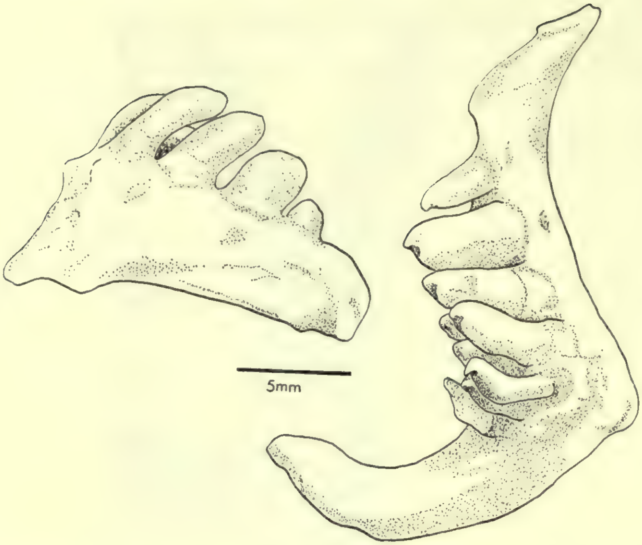

FIG. 62. The left pharyngeal bone from the lectotype of *Barbus longifilis*.

tooth is taller and more flattened laterally than the first. A small concavity on the posterior face of the crown creates a slight hook, the hook and the concavity progressively enlarge on teeth 3, 4 and 5. The teeth of the second and third rows are small, less extreme versions of the posterior tooth on the inner row.

*Coloration*. The body of preserved specimens is brassy, slightly darker on the back than on the belly. A band of dark-brown pigment is present on the middle third of the fin membrane of the dorsal and pelvic fins and extends from the middle to the end of the pectoral, anal and caudal fins, the density of the pigment varies considerably from specimen to specimen, especially the caudal fin.

DISTRIBUTION. The specimens examined came from the Loama and Kanséhété rivers, Congo.

DIAGNOSIS AND AFFINITIES. *Barbus longifilis* is a member of the *Barbus bynni* group (see p. 36). The much longer barbels distinguish this species from *Barbus bynni* and *Barbus gananensis*. In other respects it most closely resembles *Barbus oxyrhynchus* and were the two species found in the same area it may be difficult to assign some individual specimens (especially preserved material) to either of the two species. The longer barbels and more heavily pigmented fins in *Barbus longifilis* will usually enable it to be distinguished from *Barbus oxyrhynchus* where locality data are unavailable.

Cooke (1958 : 26) presents some evidence to suggest that some Athi–Tana faunal elements had been able to move across the Lake Victoria area. He cites the presence of the Athi river species *Tilapia nigra* which occurs in the mid-Pleistocene beds at Rawi in the Kavirondo Gulf. The relationship of Lake Victoria to the headwaters of the Congo in Pleistocene times is discussed on page 22. There is just a possibility that there could have been a movement of *Barbus oxyrhynchus* (or its ancestor) from the Athi into the Congo before the rift valley broke the connection (see fig. 4 in Cooke, *op. cit.*) and that *Barbus longifilis* represents a surviving population descended from this migration.

### ***Barbus macrolepis*** Pfeffer 1889

*Barbus macrolepis* Pfeffer, 1889, *Jb. hamb. wiss. Anst.* **6** (2) : 17 ; Pfeffer, 1893, *Jb. hamb. wiss. Anst.* **10** (2) : 34, pl. 1, fig. 1 ; Pfeffer, 1896, *Thierw. O-Afr. Fische* : 63.

LECTOTYPE. The lectotype was selected by Ladiges *et alii* (1958) as a fish of 108 mm S.L. (this specimen was kindly measured for me by Dr W. Ladiges), Reg. No. H.330 from Mbusini on the Wami River, Tanzania.

DESCRIPTION. The description is based on 20 fishes, from 48 to 243 mm S.L.

| | x̄ | s.d. | s.e. | range |
|---|---|---|---|---|
| L | | | | 48 –243 mm |
| D | 33·1 | 3·5 | 0·8 | 29·9–38·2 |
| H | 27·6 | 2·3 | 0·5 | 24·4–31·3 |
| I | 7·6 | 1·4 | 0·3 | 4·6–10·1 |
| IO | 8·9 | 0·9 | 0·2 | 7·3–10·4 |
| MW | 6·8 | 0·8 | 0·2 | 5·3– 8·3 |
| Pct | 21·7 | 1·6 | 0·4 | 18·5–24·6 |
| CPl | 14·6 | 1·9 | 0·4 | 11·4–20·3 |
| CPd | 14·8 | 1·4 | 0·3 | 12·9–17·2 |
| Snt | 7·9 | 1·7 | 0·4 | 5·8– 9·0 |
| Ab | 3·5 | 1·3 | 0·3 | 1·6– 6·3 |
| Pb | 5·8 | 2·5 | 0·6 | 1·4– 9·0 |

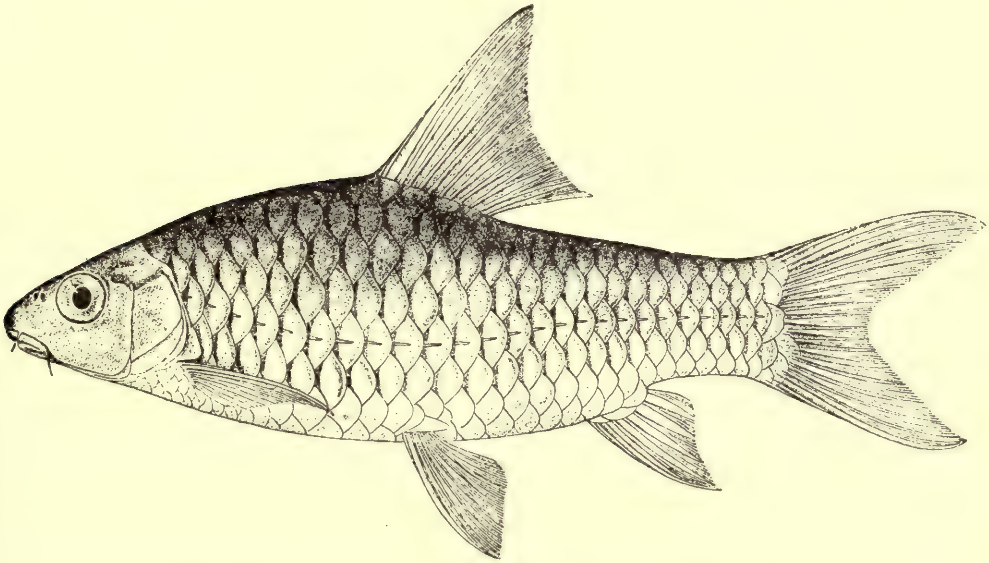

FIG. 63. *Barbus macrolepis* (from Boulenger 1911a).

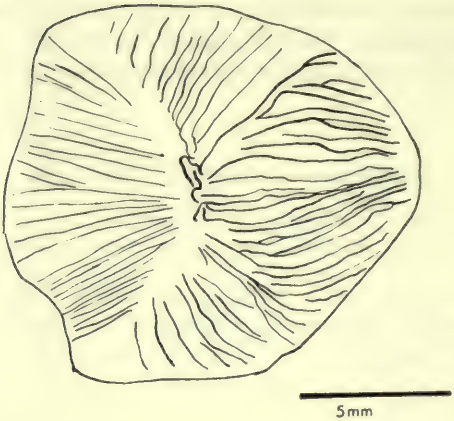

FIG. 64. A scale from the shoulder of *B. macrolepis* to show the position of the striae.

The three paralectotypes examined have the overall body shape of the figured example. The larger fish have a straighter ventral profile and a more humped back. The mouth is sub-terminal or just ventral, horse-shoe shaped ; in all the specimens the lips are slightly thickened and fleshy.

Of four specimens radiographed, three had 36 vertebrae and one had 37.

*Dorsal fin.* Has four unbranched rays and 9 (f.7) or 10 (f.13) branched rays. The last unbranched ray is weakly ossified with persistent articulations distally. The length of the non-articulated part ranges from 8·7 to 20·8 per cent S.L. with a mean value of 15·3. The whole ray though, when unbroken, is 35 per cent of the S.L. which gives a high dorsal fin, with a markedly concave dorsal margin. This ray is more elongated in larger fish. The syntypes have a very small sheath of scales at the base of the dorsal fin. This sheath is not present in the larger fish ; as there is no sign of physical damage it presumably has been lost as a result of growth. The leading edge of the dorsal fin is slightly in advance of the pelvic fin.

The *anal fin* has three unbranched rays and five branched rays. The last ray of the latter is in some cases markedly bifurcated.

*Squamation.* There are 22 (f.7), 23 (f.5), 24 (f.4) or 25 (f.1) scales in the lateral line ; 3·5 (f.6) or 4·5 (f.12) scales between the dorsal mid-line and the lateral line and 3 (f.1), 3·5 (f.7) or 4·5 (f.1) scales between the lateral and the ventral mid-line. On several specimens the scales could not be counted reliably. One and a half (f.4) or 2·5 (f.16) scale rows are present between the lateral line and the insertion of the pelvic fin. There are 12 scales around the caudal peduncle.

The striae on the scales are characteristic (fig. 64). They are comparatively sparse on the exposed portion of the scale and converge towards the posterior edge of the scale. In this respect they contrast significantly with those of *Barbus oxyrhynchus* (fig. 81).

*Pharyngeal bones and teeth* (figs. 65 and 66). The first tooth of the inner row is small, conical with a small spoon-shaped depression at the crown. The second tooth is much thicker and higher with a hooked crown. The teeth become progressively thinner posteriorly and the hook and the depression become more exaggerated. The pharyngeal tooth formula is 2.3.5.–5.3.2.

*Gill rakers.* There are 12–14 broad, hooked gill rakers on the ventral limb of the first gill arch.

*Coloration.* Preserved specimens are light brown on the back and a paler silvery-brown on the lower part of the flanks. The scales are dark edged. The caudal and dorsal fins are brownish, the other fins are hyaline.

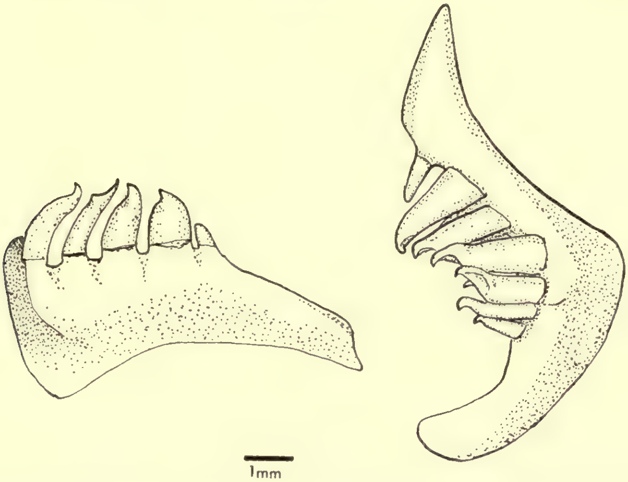

FIG. 65. The left pharyngeal bone from a specimen of *B. macrolepis* of 94 mm S.L.

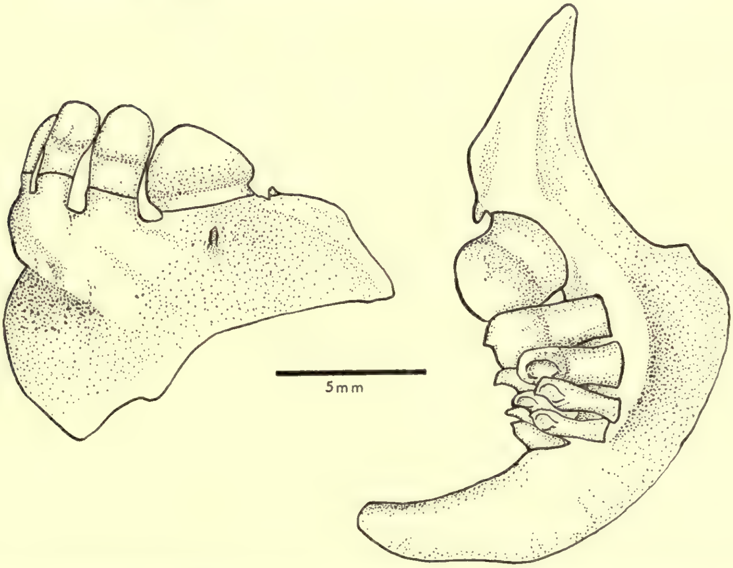

FIG. 66. The left pharyngeal bone from a specimen of *B. macrolepis* of 243 mm S.L.

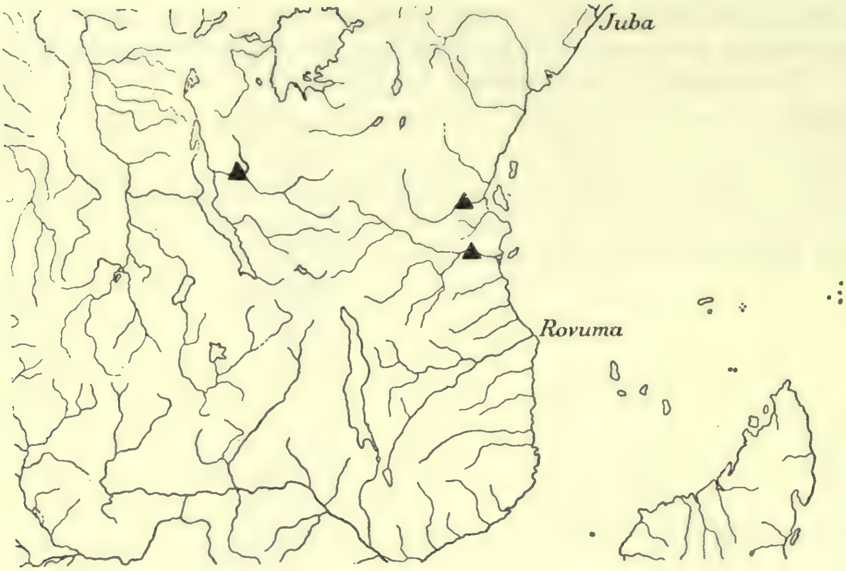

FIG. 67. A map of the distribution of *Barbus macrolepis*.

DISTRIBUTION. This species is known from Katare (or Kotare), Malagarasi swamp; from the Wami, Ruaha and Rufiji rivers, Tanzania.

The distribution of this species is rather unusual in that it is confined to a narrow belt between 5 and 8 degrees South but covers a wide longitudinal range from Malagarasi to near the Tanzanian coast. The Malagarasi river drains westwards into Lake Tanganyika whilst the other two rivers flow eastward into the Indian Ocean.

The Malagarasi has certain Congo faunal affinities and its geological history suggests that it was once part of the Congo system. The eastward flowing rivers do not have any Congo links.

DIAGNOSIS AND AFFINITIES. *Barbus macrolepis* is a distinctive species. The body is deep, the last simple dorsal fin ray is tall and weak, the caudal peduncle is nearly as deep as it is long and the striae on the scales converge markedly. The striae on the scales of *Barbus marequensis* are parallel, but the tall crescentic dorsal fin of the larger specimens is also present in specimens of *Barbus marequensis* from the Zambezi river to the south of the Rufiji river.

The more heavily ossified last simple ray of the dorsal fin of *Barbus oxyrhynchus* in the rivers to the north of the Wami and the parallel sinuous striae on the scales are easily distinguished points of difference from *Barbus macrolepis*.

Poll (1967 : 181) is of the opinion that *Barbus jubbi* has some marked similarities to *Barbus macrolepis*, principally in the high number of dorsal fin rays and the low number of scales in the lateral line series. However, the striae on the scales are quite different, as is the dorsal fin spine and at the moment I am inclined to think that the resemblances are spurious.

A very much greater degree of morphological similarity exists between *Barbus macrolepis* and *Barbus lagensis* from Nigeria. Both species have ten unbranched rays in the dorsal fin ; a high but weak fourth unbranched ray in the dorsal fin ; a comparable low number of scales in the lateral line series and very similar striations on the scales.

I have not seen sufficient *Barbus lagensis* material to comment further on the relationships of these two species but both seem very different from the other African *Barbus* species and if the characters in common are not the result of convergence, then the real possibility exists that these two species are related and if so then their distribution may indicate that they are relicts of an early invasion of *Barbus* species (see p. 132). I have not seen any other African *Barbus* species that have converging striae on their scales and the combination of a deep body, large scales and a high dorsal fin without a well-ossified dorsal spine is also unique. Some of these characters are found in some Asian *Barbus* species, e.g. converging striae are found in *Barbus longispinis* Günther, this Celanese species has striae which converge more with age but it has a strong dorsal spine. *Barbus macropus* Blkr. and *Barbus huguenini* Blkr. respectively from Borneo and Sumatra are deep-bodied fishes with large scales and few converging striae ; however, they have a serrated dorsal spine. I have not been able to find any mainland Asiatic species which have all the characters under discussion, but it seems that the presence of converging striae is more frequent in Asiatic *Barbus* species than it is in African *Barbus* species. I have not been able to examine as many Indian species as I would have liked but the occurrence of the converging striae in some of the Asiatic island species suggests that it may be a primitive feature (or at least an ancient one) which is present in two African species. At the moment I cannot with any certainty align *Barbus macrolepis* with any Asiatic species because it is impossible to show that the similarities in the pattern of scale striae are not due to convergence. If it is not due to convergence, then it is possible that there may be some fairly close relationship between a group of Asiatic *Barbus* species and a pair of African species. This idea, though, assumes that the differences in the dorsal spines are of less significance than the similarities in the scale striations and sadly this is a matter on which I have no information at all.

### ***Barbus mariae*** Holly 1929

*Barbus mariae* Holly, 1929, *Anz. Akad. Wiss. Wien* **66** (4) : 34 ; Copley, H., 1958, *Common Freshwater Fishes of E. Africa* : 78–80.

*Barbus rhinoceros* Copley, 1938, *Jl. E. Africa Uganda nat. Hist. Soc.*, **13** : 191.

NOTES ON THE SYNONYMY. It may well eventually prove necessary to synonymize *Barbus mariae* with *Barbus matris*, Holly, 1928 [*Zool. Anz. Leipzig* **85** (1–2)] from the Athi river at Nairobi. Holly's description of *Barbus matris* is very similar to that of *Barbus mariae* but I am unwilling to proceed in this matter without examining the holotype of *Barbus matris* and at the time of writing this has not been located.

LECTOTYPE. Holly described this species on the basis of two specimens of 280 mm and 295 mm total length from the Kitui river (Athi system) in Kenya. I have not seen either of these specimens which are supposed to be in the Natural History Museum, Vienna, but they could not be located by Dr P. Kahsbauer who kindly searched for them. The larger specimen is designated the lectotype on the assumption that both specimens are extant.

DESCRIPTION. The description is based on five specimens in the B.M. (N.H.) collections of standard lengths, 86, 105, 112, 117 and 342 mm from the Athi river.

| | $\bar{x}$ | range |
|---|---|---|
| D | 26·9 | 24·4–29·5 |
| H | 30·7 | 30·1–32·5 |
| I | 8·5 | 5·5–10·4 |
| IO | 6·8 | 5·8– 8·5 |
| MW | 5·2 | 4·5– 7·0 |
| Pct | 22·5 | 21·9–22·5 |
| CPl | 17·3 | 16·1–19·6 |
| CPd | 10·6 | 9·3–12·9 |
| Snt | 9·9 | 8·9–10·4 |
| Ab | 2·7 | 1·2– 3·8 |
| Pb | 5·3 | 4·5– 5·8 |

All measurements are expressed as percentages of the standard length. With this particular sample it was not considered useful to calculate the standard deviation and the standard error.

*Barbus mariae* is a distinctive species. The upper jaw has a remarkable median protrusion (the 'rhinoceros horn' of Copley 1958) when the mouth is open. This is caused by the fish having a large kinethmoid (*sensu* Alexander 1966). The antero-ventral edge of the labial part of the premaxilla is gently curved and overhangs the lower jaw giving a 'clupeoid' appearance to the jaws.

The body is long and thin, the dorsal fin has its origin in the posterior half of the body more or less vertically above the insertion of the pelvic fin.

*Dorsal fin.* It has IV–9 rays. The fourth unbranched ray is heavily ossified, smooth and from 17·5 to 32·6, $\bar{x} = 29·0$, of standard length (negatively allometric). The dorsal margin of the fin is markedly concave.

*Anal fin.* With III–5 rays.

*Squamation.* Holly gives 30 or 31 for the lateral line scale count of the specimens he described. The specimens I examined have 27 (f.1), 28 (f.1), or 29 (f.3) scales. The difference is probably attributable to the different techniques used in counting these scales. The figures given by Holly agree with the complete number of scales in the lateral line series if 27 or 28 are present to the end of the hypurals. There are 12 scales around the caudal peduncle, 4·5–5·5 between the dorsal mid-line and the lateral line and 4·5 between the lateral line and the ventral mid-line. One and a half or 2 scales were present between the lateral line and the base of the pelvic fin.

*Pharyngeal bones and teeth.* The pharyngeal tooth formula is 2.3.5.–5.3.2. The first tooth in the inner row is about two-thirds of the length of the second. The second tooth is the widest. All in this row are unicuspid and recurved and the

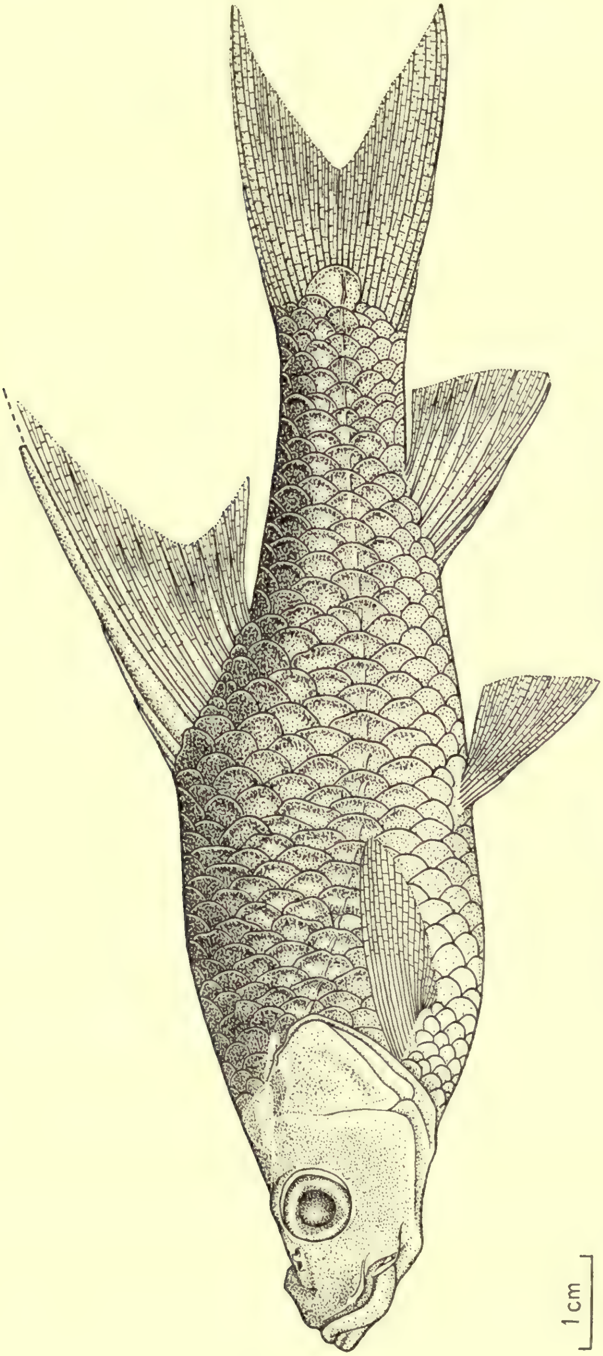

Fig. 68. *Barbus mariae*: a B.M. (N.H.) of 117 mm S.L.

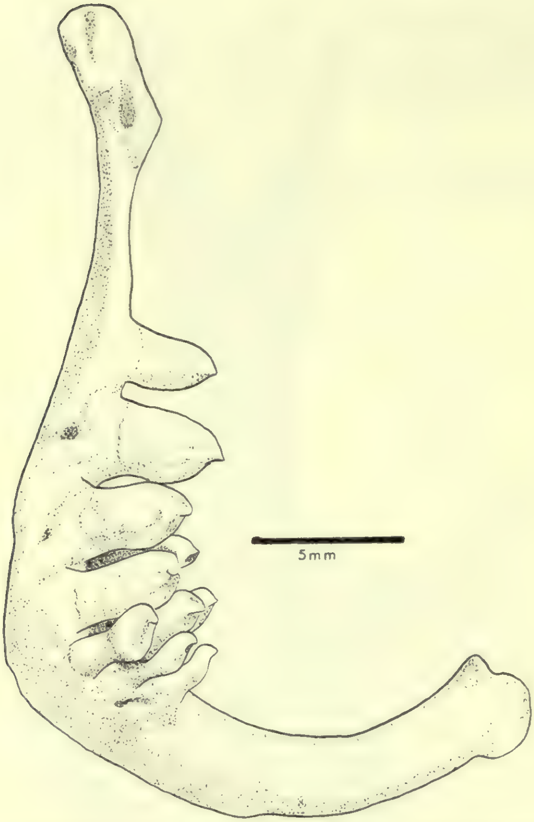

FIG. 69. The left pharyngeal bone from a specimen of *Barbus mariae* of 342 mm S.L.

teeth become more hooked, taller and thinner posteriorly. Only the pharyngeal teeth of the largest specimen were examined.

*Gill rakers.* On the largest specimen 9 + 1. The gill rakers were widely spaced and hooked forward. This number is lower than is usual among the large *Barbus* species under consideration in this revision.

*Coloration.* Holly's (*op. cit.*) remarks on the coloration match the colour of the preserved specimens I examined. The back is dark ochre-brown shading to a silvery-yellow in the belly. The fins are very light brown and the scales have dark edges. Copley (1958) states that the live fish are olive-brown on the back and silvery on the belly.

DISTRIBUTION. The five specimens 1936.12.22 : 35–39 in the B.M. (N.H.) collections are from the Athi river. Specimen No. B.M. (N.H.) 1937.6.4 : 16 has only the locality Kenya. Copley (1958) records it from the Athi and Tana systems, he also mentions that they can weigh up to 48 lb.

DIAGNOSIS AND AFFINITIES. *Barbus mariae* is most easily distinguished by the 'rhinoceros horn'-like development of the kinethmoid and the 'clupeoid' appearance of the upper jaw. *Barbus mariae* is sympatric with *Barbus oxyrhynchus* but lacks many of its characters and I am unable, at the moment, to comment further on its relationships.

## ***Barbus microbarbis*** David and Poll 1937

*Barbus microbarbis* David & Poll, 1937, *Annls. Mus. r. Congo Belge* Zool. (1) **3** (5) : 261 (only the holotype).

HOLOTYPE. A fish of 216 mm S.L. from Lake Luhondo, Rwanda ; M.A.C.T. No. 41847. The two paratypes (M.A.C.T. Nos. 41848, 41849) do not belong to this species, nor do any of the other specimens in the M.A.C.T. collection (Nos. 56449–56455, 56479, 92966–92968, 94219–94220). This species is split because the holotype has a sub-terminal mouth, five teeth in the inner pharyngeal row, a smoothly curved pharyngeal bone outline, nine branched rays in the dorsal fin and 15 gill rakers on the lower limb of the first gill arch (in contrast to the ventral mouth, horny covered lower jaw, four teeth on the inner pharyngeal row, an oddly shaped pharyngeal bone, 10 branched dorsal fin rays and 19–20 gill rakers on the lower limb of the first gill arch of the paratypes and the other M.A.C.T. specimens). All the specimens previously included in this species are now considered to belong to *Varicorhinus ruandae* Pappenheim, & Boulenger, 1914.

DESCRIPTION. The description is based on the holotype. D = 31·0 ; H = 23·6 ; I = 5·6 ; IO = 9·2 ; MW = 7·4 ; Pct = 19·9 ; CPl = 15·7 ; CPd = 11·1 ; Snt = 3·3. The mouth is sub-terminal, the lower jaw is curved without a horny margin and both anterior and posterior barbels are present although very short. Scales on the posterior part of the body have parallel striae but are radiately striated on the shoulders ; 32 scales in the lateral line, 12 around the caudal peduncle, 5·5 between the dorsal mid-line and the lateral line ; 5·5 between the lateral line and the ventral mid-line and 2·5 between the lateral line and the base of the pelvic fin.

The dorsal fin has four unbranched rays, the last is moderately thickened and ossified into a smooth spine, the non-articulated part of which is 11·0 per cent of the standard length. There are nine branched rays and the dorsal margin of the fin is slightly concave.

The *anal fin* has three unbranched and five branched rays. David & Poll (1937) give six branched rays but they were apparently misled by the complete bifurcation of the last ray.

*Pharyngeal bones and teeth.* The right pharyngeal bone is shown in fig. 71 ; the fifth tooth in the inner row is notable for the presence of a ridge across the concave crown. All the teeth are hooked.

There are 16 short, broad *gill rakers* on the lower limb of the first gill arch.

*Coloration.* Described by David & Poll (*op. cit.*) as dark grey on the back, lighter grey below. Scales with a black border. The colour now is dark brown on the back and lighter brown below.

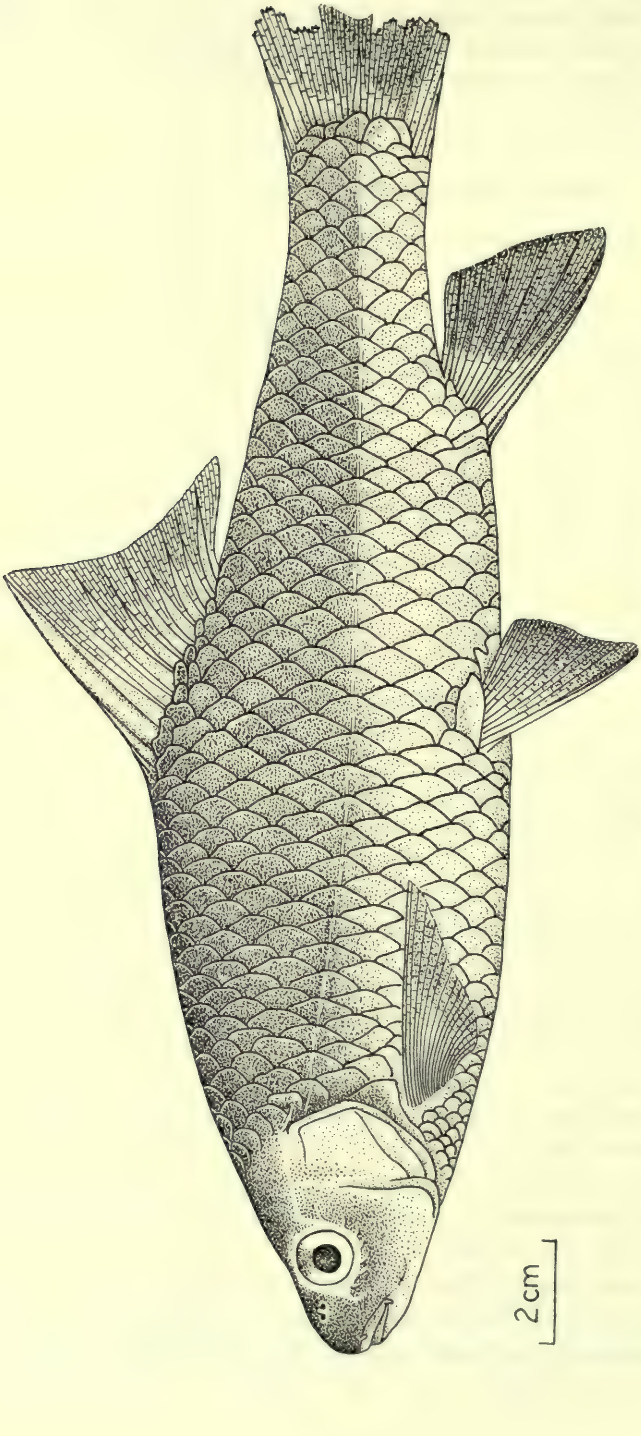

FIG. 70. *Barbus microbarbis* holotype.

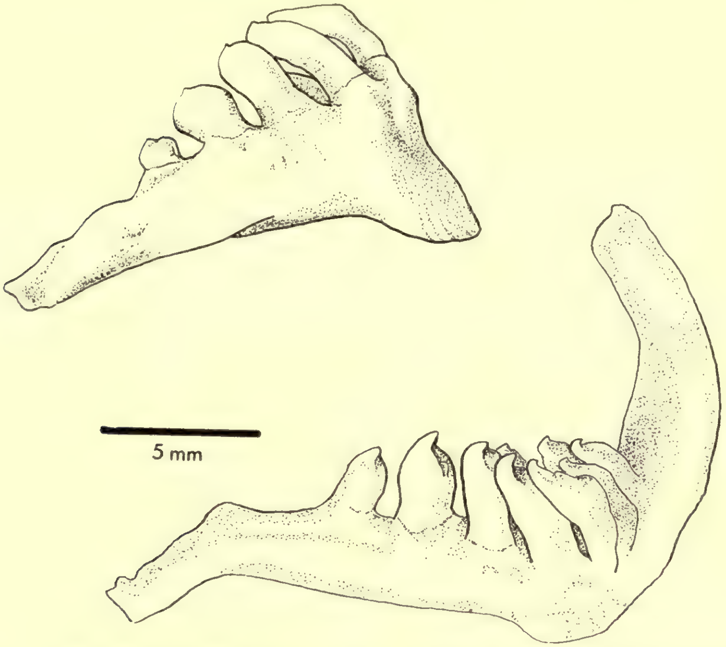

FIG. 71. The right pharyngeal bone from the holotype of *Barbus microbarbis*.

DISTRIBUTION. This species is known only from Lake Luhondo, Rwanda.

DIAGNOSIS AND AFFINITIES. *Barbus microbarbis* is characterized by having very short barbels and a wide sub-terminal mouth with a gently curving lower jaw. In these two characters this species approaches members of the ill-defined genus *Varicorhinus* Rüppell but is clearly separate from *Varicorhinus ruandae* (see above) with which it is sympatric.

It is unwise to speculate too much on the basis of one specimen. *Barbus microbarbis* could be an abnormal specimen of *Barbus altianalis* or *Barbus acuticeps*. Groenewald (1958) has shown how the mouth shape can change markedly. This individual could be a hybrid between a *Barbus* species and a *Varicorhinus* species.

Without more specimens and a greater knowledge of the fauna of the area the relationships and nature of this species must be left in abeyance.

## ***Barbus microterolepis*** Boulenger 1902

*Barbus microterolepis* Blgr., 1902, *Ann. Mag. nat. Hist.* (7) **10** : 426 ; Blgr., 1911, *Cat. Afr. Fish* **2** : 23, fig. 5.

HOLOTYPE. A fish of 118 mm S.L. from the Maki river, Lake Zwai, Ethiopia, B.M. (N.H.) Reg. No. 1902.12.13 : 220.

DESCRIPTION. The description is based on the only known specimen of this species. All measurements are expressed as percentages of the standard length.

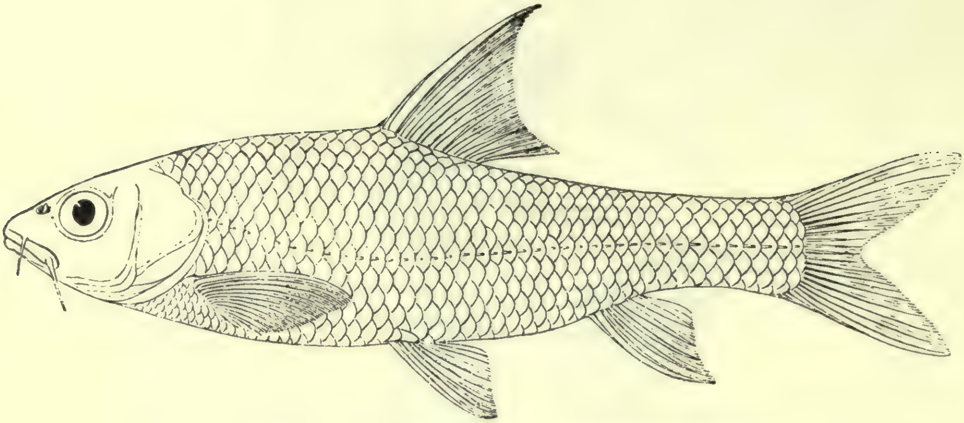

FIG. 72. *Barbus microterolepis* holotype (from Boulenger 1911a).

D = 27·1 ; H = 25·4 ; I = 7·6 ; IO = 7·6 ; MW = 5·9 ; Snt = 7·6 ; Pct = 21·2 ; CPl = 16·9 ; CPd = 10·2 ; Ab = 5·1 ; Pb = 6·8.

The shape of the body can be seen in fig. 72.

*Squamation.* The lateral line has 40 scales. There are 7·5 scale rows between the dorsal mid-line and the lateral line and 6·5 scale rows between the lateral line and the ventral mid-line. There are four scales between the lateral line and the base of the pelvic fin. Around the caudal peduncle there are 15 or 16 scales. The scales bear numerous fine parallel striae.

*Dorsal fin.* The dorsal fin origin is slightly in front of the pelvic fin insertion. It has four unbranched rays, the last of which is ossified into a smooth spine of length 22·9 per cent. There are eight branched rays the last of which is bifid.

The *anal fin* has five branched rays and three unbranched rays.

*Pharyngeal bones and teeth.* The first tooth in the inner row (fig. 73) is small and conical, the second tooth is longer and thicker with a recurved, unicuspid crown. The other three teeth in this row become progressively thinner and more hooked. There are no molariform teeth. The pharyngeal tooth formula is 2.3.5.–5.3.2.

*Gill rakers.* Ten moderately stout, slightly curved gill rakers are present on the lower limb of the first gill arch. Three gill rakers are present on the upper limb.

*Coloration.* Boulenger (*op. cit.*) describes the colour of the preserved specimen as olive above, silvery beneath.

DISTRIBUTION. This species is known only from the Maki river, which is a fast-flowing stream rising in the hills of Gouaza and emptying into Lake Zwai.

AFFINITIES. Any conclusions about this species, based on one specimen, must be regarded as tentative. The Zwai basin contains two other endemic cyprinids, *Barbus ethiopicus* and *Garra makiensis* (Blgr. 1911a ; Menon 1964). The geology of the area is not known in enough detail to be able to decide whether the endemism

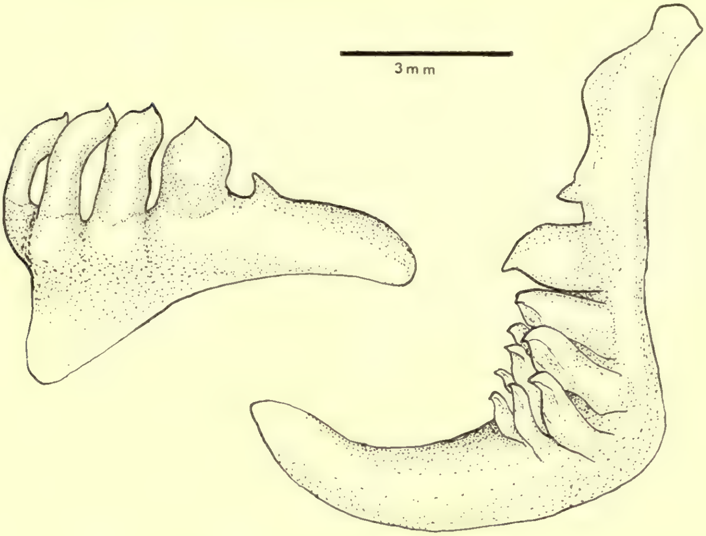

FIG. 73. The left pharyngeal bone from the holotype of *Barbus microterolepis*.

is the result of a long isolation or not. There are several possibilities concerning *Barbus microterolepis*. It could be an abnormal specimen of *Barbus intermedius* in which the number of scales has been increased by a chance mutation. *Barbus intermedius* lives in the Zwai basin and differs from *Barbus microterolepis* in the size of the scales. *Barbus microterolepis* could be a valid species descended from a common ancestry with *Barbus intermedius* having an increase in scale numbers. If this is so one must conclude that the species must be rare or inhabiting inaccessible regions as only one fish has ever been collected. A third possibility is that *Barbus microterolepis* is a hybrid between the small-scaled *Barbus ethiopicus* of Lake Zwai and *Barbus intermedius*. There is no evidence at the moment that *Barbus microterolepis* is not a valid species but more specimens are needed before any firm conclusions regarding its affinities can be reached.

### ***Barbus mirabilis*** Pappenheim and Boulenger 1914

*Barbus mirabilis* Pappenheim & Blgr., 1914, *Wiss. Ergebn. dt. ZentAfr. Exped.* Zool. (3) **5** : 239.

HOLOTYPE. A fish of 353 mm S.L., Z.M.B. Reg. No. 19059.

DESCRIPTION. The description is based on the holotype as I have not been able to find any other specimens which have been referred to this species. D = 30·8 ; H = 24·6 ; I = 4·2 ; IO = 10·0 ; MW = 7·1 ; Pct = 19·8 ; CPl = 13·8 ; CPd = 11·9 ; Snt = 8·5 ; Ab = 4·7 ; Pb = 5·4. All these measurements are expressed as percentages of the standard length.

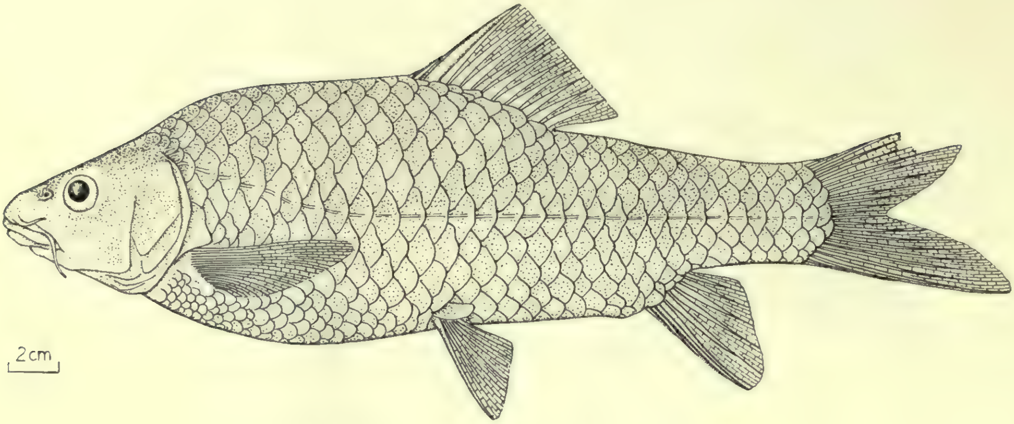

FIG. 74. *Barbus mirabilis* holotype.

The shape of the body can be seen in fig. 74 and it presents a rather bulky appearance.

*Squamation.* The striae on the scales are slightly diverging, less so on the shoulder scales than on the flanks or belly. There are 28 scales in the lateral line (Pappenheim and Boulenger's count of 31 is the total number). Five and a half scale rows are between the dorsal mid-line and the lateral line and the same number between the lateral line and the ventral mid-line. Three scale rows lie between the lateral line and the base of the pelvic fin. The scales on the chest are reduced in size and are less well formed. There are 12 scales around the caudal peduncle.

The mouth is sub-terminal and crescentic with a continuous lower lip.

*Dorsal fin.* Has four unbranched rays. The last ray is ossified into a smooth spine, the non-articulated part of which is 9·6 per cent of the standard length. There are ten branched rays. The origin of the dorsal fin is in front of the pelvic fins. There is no sheath of scales at the base.

*Coloration.* The preserved fish is pale brown in colour with a darker lower lobe of the caudal and a dark edge to the pectoral fins. The back and sides above the lateral line are slightly darker than the belly.

*Gill rakers.* There are 10 gill rakers on the lower arm of the first gill arch.

*Pharyngeal bones and teeth.* The pharyngeal teeth (figs. 75 and 76) have slightly hooked crowns. There is little enlargement of the second tooth in the inner row. The pharyngeal tooth formula is 2.3.5.–5.3.2.

DISTRIBUTION. Known only from Mawambi on the Ituri river (Congo system).

AFFINITIES. In its general shape, coloration, striations of the scales, scale and gill raker counts and pharyngeal teeth, *Barbus mirabilis* closely resembles *Barbus somereni*. The barbels are shorter than in *Barbus somereni* but the unique specimen of *Barbus mirabilis* is much bigger than the largest *Barbus somereni* examined. *Barbus somereni* also usually lacks the dark edge to the pectoral fin.

Without more specimens I cannot synonymize these two species nor state their relationship with any degree of certainty. It seems possible that, although *Barbus mirabilis* comes from the Congo system on the other side of the rift valley, it was found only some 150 km from the Ruwenzori mountains where *Barbus somereni* is common and could represent a population of *Barbus somereni* that lived in the westward-flowing rivers of that area and became isolated when the rift valley formed. There is a certain amount of circumstantial evidence to support this idea. *Barbus*

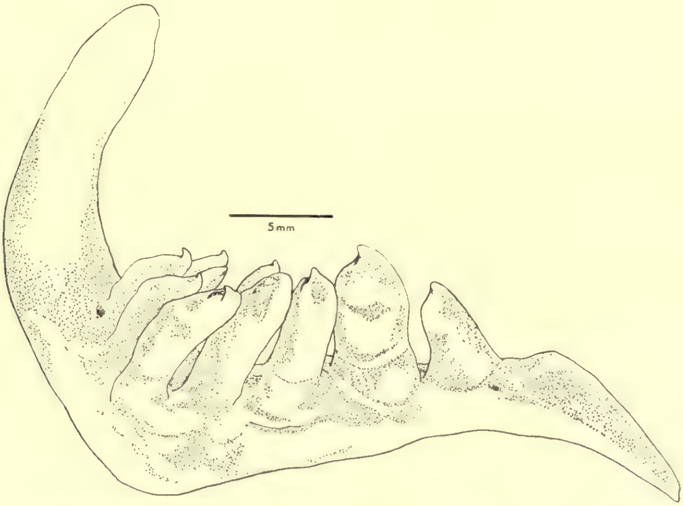

Fig. 75. The dorsal aspect of the left pharyngeal bone from the holotype of *Barbus mirabilis*.

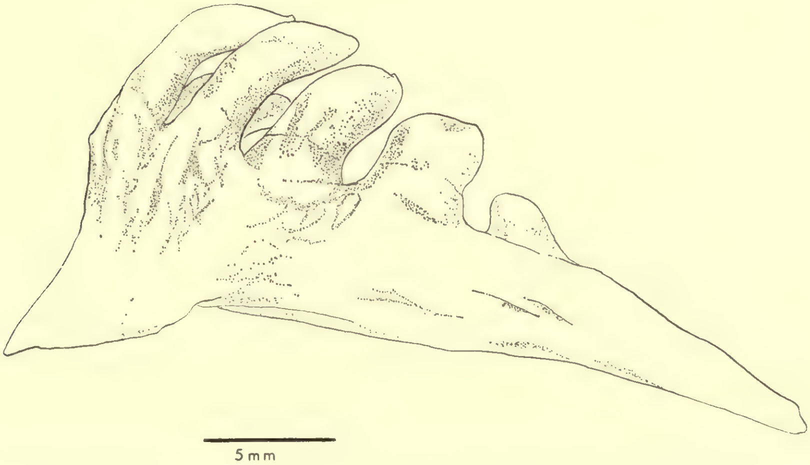

Fig. 76. The lateral aspect of the left pharyngeal bone from the holotype of *Barbus mirabilis*.

*somereni* has a wide, scattered distribution, usually at high altitudes suggesting that it was once a widespread species and changes in the environment (whether tectonic or climatic) or competition have driven it into higher altitude streams. What little geological evidence is available (see under *Barbus altianalis*) suggests that the Congo watershed extended further eastwards than it does now and that its eastern extremities were cut off and their direction changed by the rift valley formation. It would therefore seem possible that an old-established large *Barbus* species (which this must be if the arguments have any veracity at all) could be found on both sides of the rift valley. More specimens from Mawambi are badly needed before this matter can be pursued further. I have not been able to examine Pappenheim & Boulenger's (*op. cit.*) unique specimen of *Barbus mawambi* also from Mawambi but from their description and figure I am tempted to think that this species could be the same as *Barbus mirabilis.*

## ***Barbus oxyrhynchus*** Pfeffer 1889

*Barbus oxyrhynchus* Pfeffer, 1889, *Jb. Hamb. Wiss. Anst.* **6** (2) pl. 8 ; Pfeffer, 1896, *Thierw. O-Afr. Fische* : 64.

*Barbus tanensis* Günther, 1894, *Proc. zool. Soc. Lond.* : 90, pl. 11 ; Blgr., 1911, *Cat. Afr. Fish* **2** : 58 ; Fowler, 1936 (Part), *Proc. Acad. nat. Sci. Philad.*, **88** : 287, fig. 50 (as *Barbus* (*Lanceabarbus*) *tanensis*).

*Barbus hindii* Blgr., 1902, *Proc. zool. Soc. Lond.* (2) : 222, pl. 16, fig. 1 ; Pappenheim & Blgr., 1914, *Wiss. Ergebn. dt. ZentAfr. Exped.* Zool. (3) : 239 ; Pellegrin, 1909, *Mem. Soc. zool. Fr.* **22** : 281–298.

*Barbus* (*Capoeta*) *perplexicans* Blgr., 1902, *Proc. zool. Soc. Lond.* (2) : 223, pl. 16, fig. 2 ; Pellegrin, 1909, *Mem. Soc. zool. Fr.* **22** : 281–298.

*Barbus labiatus* Blgr., 1902, *Proc. zool. Soc. Lond.* (2) : 223, pl. 17, fig. 1.

*Barbus krapfi* Blgr., 1911, *Cat. Afr. Fish* **2** : 54.

*Barbus mathoiae* Blgr., 1911, *Cat. Afr. Fish* **2** : 66.

*Barbus ahlselli* Lönnberg, 1911, *K. svenska Vetensk. Akad. Handl.* **47** (6) : 39.

*Barbus athi* Hubbs, 1918, *Fieldiana* **12** (2) : 9–16.

†*Barbus babaulti* Pellegrin, 1926, *Bull. Soc. zool. Fr.* **51** : 384.

*Barbus nairobi* Holly, 1928, *Zool. Anz.* **75** (3–4) : 1–4.

*Barbus donyensis* Holly, 1929, *Sber. Akad. Wiss. Wien* (4) : 32–35.

*Varicorhinus babaulti* : Bertin & Esteve, 1947, *Catalogue des Types des Poissons* Paris : 45.

NOTES ON THE SYNONYMY. Pfeffer (1889) described *Barbus oxyrhynchus* from two small specimens from the Rufu river (Pangani system). *Barbus tanensis* was described from much larger fish (from 188 to 285 mm S.L.) from the Thika-Thika river (Tana system). *Barbus hindii, Barbus perplexicans, Barbus labiatus, Barbus krapfi* and *Barbus mathoiae,* all came from the Athi, Tana and Pangani rivers or the Lorian swamp, and they were separated principally on slight differences in proportion, especially of the lips, dorsal spine and body depth. The same characteristics were used to differentiate the other species from the same localities, viz. *Barbus ahlselli*, *Barbus athi*, *Barbus babaulti*, *Barbus nairobi* and *Barbus donyensis*.

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† Pellegrin (1935, *Revue Zool. Bot. afr.* **27**: 382) subsequently described a small *Barbus* from Lake Kivu under the name *Barbus* (*Agrammobarbus*) *babaulti*. Greenwood (1962) synonymized this species with *Barbus apleurogramma*, Blgr. 1911a. The International rules of Zoological Nomenclature (Arts. 53 and 60) require one to give a replacement name for *Barbus* (*Agrammobarbus*) *babaulti*, Pellegrin 1935, which is here rejected as a primary junior homonym of *Barbus babaulti* Pellegrin 1926; I propose that Pellegrin's Lake Kivu species be called *Barbus lapsus*.

Fowler (1936) was of the opinion that the continued separation of *Barbus hindii*, *Barbus tanensis* and *Barbus mathoiae* was unjustified. Allowing for the known vagaries of lip development (Groenewald 1958) and for the allometry of various parts of the body with growth it seems reasonable to conclude that all these nominal species from a few adjacent rivers are preferable to the same species. Certainly the adults have the same general appearance and, as the histograms indicate, normal variation (i.e. Poisson distribution) of various characters is present when large series of specimens are examined. The only species over which I have any doubts is *Barbus labiatus* (known only from two specimens) which has a shallower body and a slightly longer head than the others. But with only two specimens available I cannot attribute too much significance to slight differences.

It has not proved possible, using the characters considered useful in this paper, to divide *Barbus oxyrhynchus* into smaller groups. This is only to be expected as the overall range of morphometric characters is not very great and the head waters of the Athi and Tana systems are extremely close.

One fish (Coll. M.A.C.T. No. 47341) from the Malagarasi river was attributed to *Barbus krapfi* by David (1937) and to *Barbus lestradei* (= *Barbus caudovittatus*) by Poll (1953). *Barbus oxyrhynchus* has not been found in the Malagarasi, yet I cannot easily place this specimen with any of the Malagarasi species. The pectoral fin is slightly shorter than in *Barbus oxyrhynchus*, but in other features it corresponds well. I can only assume either that *Barbus oxyrhynchus* is found in the Malagarasi but is extremely rare or that this specimen is a deformed member of another species if it is not a new species.

A specimen in the Stockholm Museum, No. 8061, identified as *Barbus percivali* Blgr. (= *Barbus neumayeri* Fischer, *fide* Greenwood 1962 : 178) from Kibonoto on the Sanya river, belongs to *Barbus oxyrhynchus*.

There are two fish from the Ruaha river (Rufiji system) in the collection of the Central Africa Museum, Tervuren, which belong possibly to this species. The Rufiji is to the south of the Pangani and its fauna is very poorly known. These two fish are extremely deep bodied, their standard lengths are 156 and 164 mm with body depths of 38·4 and 40 per cent respectively. Their other features are within the *Barbus oxyrhynchus* range except for the dorsal spines which are short and articulated distally (respectively 11·5 and 15·2 per cent). Although at the moment, these specimens are considered as belonging to this species they are not included in the data given in the description below. Further specimens may show that the Rufiji fishes are of a different species or are a discrete population of *Barbus oxyrhynchus*. Pappenheim & Boulenger (1914) record *Barbus hindii* from the Ituri river but the very low lateral line count would seem to refer these fish to *Barbus mawambiensis*.

LECTOTYPE. The lectotype, a fish of 48 mm S.L. from the Pangani river, Hamburg Museum, No. H339, was selected by Ladiges *et alii* (1958). I have not been able to examine this specimen but it was compared for me by Dr W. Ladiges who

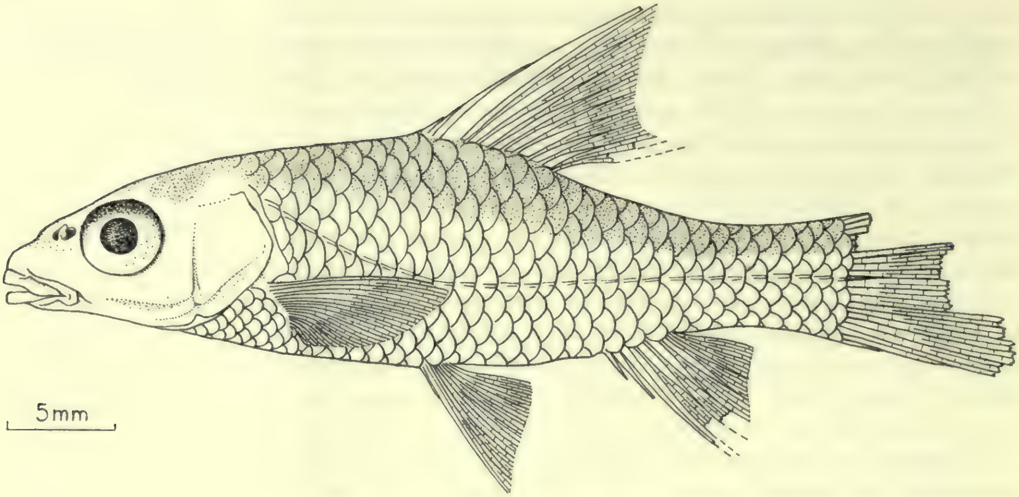

FIG. 77. *Barbus oxyrhynchus* paralectotype.

kindly sent me the largest paralectotype (40 mm S.L.) which is figured above (fig. 77).

DESCRIPTION. The description is based on 108 specimens, including, in addition to the types of *Barbus oxyrhynchus*, the types of *Barbus tanensis*, *Barbus hindii*, *Barbus perplexicans*, *Barbus labiatus*, *Barbus krapfi*, *Barbus mathoiae*, *Barbus ahlselli*, *Barbus babaulti* and *Barbus athi*. The size range of the specimens is from 28 to 369 mm S.L. Because the lectotype is a juvenile fish figs. 78, 79 and 80 show larger specimens indicating the variations produced by growth in this species.

The morphometric data are expressed in tabular form as follows and unless otherwise stated are expressed as a percentage of the standard length.

| | x̄ | s.d. | s.e. | range |
|---|---|---|---|---|
| D | 31·8 | 2·8 | 0·3 | 26·1–39·4 |
| H | 26·9 | 2·5 | 0·2 | 23·0–32·6 |
| I | 7·6 | 1·9 | 0·2 | 4·4–11·1 |
| IO | 8·9 | 1·1 | 0·1 | 6·9–12·5 |
| MW | 6·4 | 0·9 | 0·1 | 4·3– 8·7 |
| Pct | 24·4 | 1·9 | 0·2 | 21·3–28·6 |
| CPl | 16·9 | 1·4 | 0·1 | 14·1–20·0 |
| CPd | 12·8 | 1·1 | 0·1 | 10·8–15·5 |
| Snt | 8·5 | 0·9 | 0·1 | 6·3–11·0 |
| Ab | 5·9 | 1·4 | 0·1 | 3·1–10·7 |
| Pb | 7·1 | 1·4 | 0·1 | 3·6–12·4 |

The standard deviation is higher than for many species described in this paper because of the size range and marked allometry of the specimens examined. This is especially noticeable in the body depth; in fishes of less than 100 mm S.L. (measurements expressed as a percentage of the standard length unless otherwise

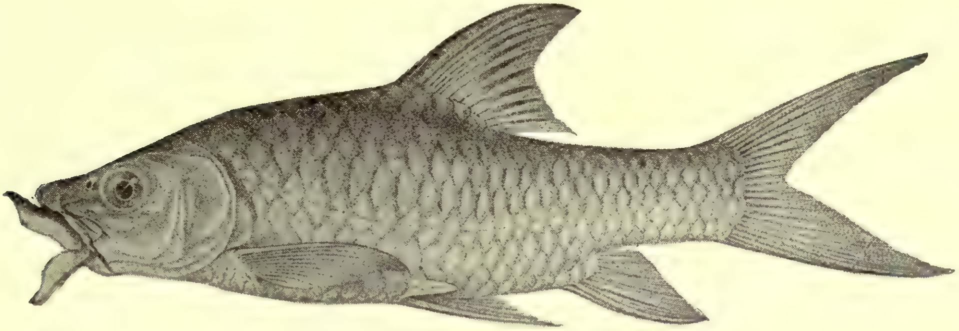

FIG. 78. *Barbus oxyrhynchus* (type of *B. labiatus* from Boulenger 1911a).

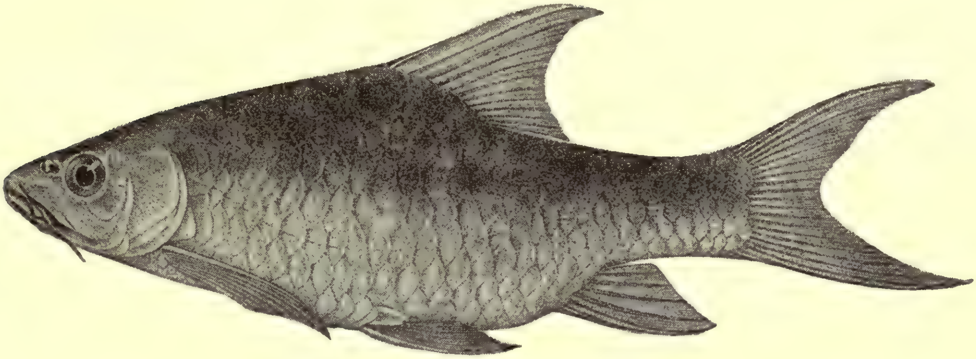

FIG. 79. *Barbus oxyrhynchus* (type of *B. hindii* from Boulenger 1911a).

stated), $\bar{x} = 29{\cdot}3$ ; s.d. = 2·2 ; s.e. = 0·4 ; range = 26·1–35·0 ; the upper end of this range is extended by two small fishes from the Athi river which have a pronounced keel leading up to the dorsal fin. Fishes of S.L. 101–170 mm, $\bar{x} = 32{\cdot}2$ ; s.d. = 1·6 ; s.e. = 0·2 ; range = 29·5–35·8. Fishes of S.L. above 171 mm, $\bar{x} = 33{\cdot}6$ ; s.d. = 2·7 ; s.e. = 0·5 ; range = 28·4–39·4. In this case the lower end of the range is extended by the shallow-bodied specimens previously referred to *Barbus labiatus* (see below).

The typical adult fish has a fairly flat ventral profile. The dorsal profile rises sharply from the snout to the origin of the dorsal fin after which it follows a sloping concave course down to the caudal fin. The same type of body shape is shown by the two specimens attributed to *Barbus labiatus* except that the body is less deep. The snout is obtusely pointed. The mouth ranges from ventral and curved in most specimens through the wide, cutting mouth of the types of *Barbus perplexicans* to the rubber lips of the type of *Barbus labiatus*. The mean length for the pectoral fin is sufficiently great for it to serve as a diagnostic character for the species.

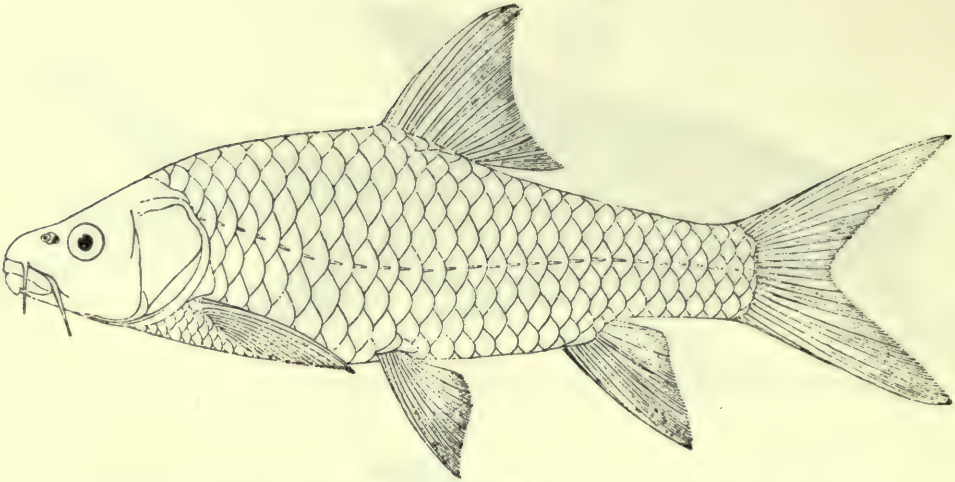

FIG. 80. *Barbus oxyrhynchus* (type of *B. krapfi* from Boulenger 1911a).

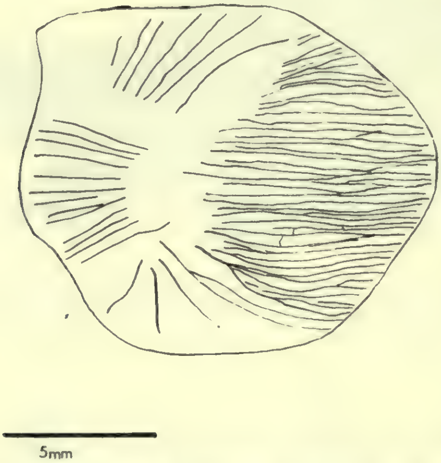

FIG. 81. A scale from a specimen of *Barbus oxyrhynchus* (the type of *B. mathoiae*) to show the distribution of the striae.

The caudal peduncle is compressed, short and deep with a mean length/depth ratio of 1·32.

*Squamation.* The scales bear many parallel or slightly converging striae (fig. 81). The lateral line count is low, from 21 to 28 scales; 21 (f.1), 22 (f.10), 23 (f.15), 24 (f.36), 25 (f.30), 26 (f.8), 27 (f.6), 28 (f.1). The type of *Barbus labiatus* has 24 on one side and 27 on the other. The lateral line follows a rather dipping course. There are 4·5 (f.100) rarely 3·5 (f.6) or 5·5 (f.2) scales between the dorsal mid-line and the lateral line and 4·5 (f.81) rarely 3·5 (f.16) or 5·5 (f.3) scales between the lateral line and the ventral mid-line. This count was unobtainable from some specimens. There are 2·5 (f.65), 2 (f.4) or 1·5 (f.32) scales between the lateral line and the base of the pelvic fin. Again this count was not possible in some specimens. Around the caudal peduncle there are 12 (f.99) or 11 (f.5) scales; this count too was unobtainable for some specimens.

*Dorsal fin.* There are four unbranched rays. The last of these is ossified into a long, moderately broad, straight or gently curving spine. This fourth ray has a mean length of 25·3 with a range from 16·6 to 35·7 per cent, s.d. = 4·6, s.e. = 0·5.

There are from eight to ten branched rays: 8 (f.5), 9 (f.82), 10 (f.21); the types of *Barbus oxyrhynchus* are somewhat atypical in having only eight branched rays. The dorsal margin is strongly concave and the base of the dorsal fin frequently has an enveloping sheath of scales.

The *anal fin* has three unbranched rays and five (very rarely six) branched rays.

*Pharyngeal bones and teeth.* The pharyngeal tooth formula is constant at 2.3.5.–5.3.2. The first tooth in the inner row is tall, thin and has a slightly hooked crown. It is slightly angled towards the second tooth. This tooth is longer than wide (fig. 83) and again hooked distally. Teeth 3, 4 and 5 become progressively thinner and develop articular surfaces on the posterior face of the crown. The fifth tooth is distinctly recurved but the terminal hook remains. The teeth of the second and third rows resemble the fifth tooth of the ventral row in general shape but are much smaller.

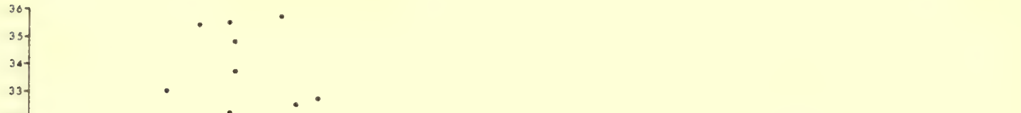

FIG. 82. Scatter diagram of the dorsal spine length as a percentage of the standard length against the standard length for the entire sample of *Barbus oxyrhynchus*.

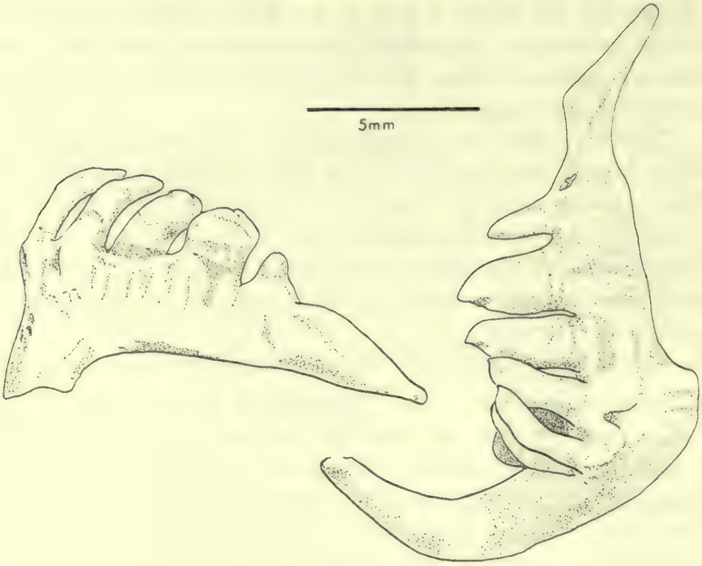

FIG. 83. The left pharyngeal bone from *Barbus oxyrhynchus* (a syntype of *B. tanensis*).

The *gill rakers* range from 11 to 16 on the lower limb of the first gill arch.

*Coloration.* Copley (1958) states that the colour of *Barbus tanensis* varies in live fish from olive-green to deep olive-brown on the back shading to silver on the belly. Fowler (1936) figures *Barbus tanensis* with a dark spot on the caudal peduncle; I have not seen this in any of the specimens I examined. The colour in alcohol is sandy-brown on the back shading to a pale brown to silver on the belly. The scale margins are frequently a deeper shade of brown than the centre of the scale.

DISTRIBUTION. Specimens are known from the Rufu river, Pangani system; the Kibwesi, Makindu, Tsavo, Regati, Mathoiya and Thika-Thika rivers, Athi–Tana systems; the Rufiji river; Nero–Narok system, Lorian swamp (in the Northern Euasso Nyiro system). This species is widespread throughout the Athi and Tana systems (Copley 1958).

The locality G. el Narua given in Boulenger (1911a: 57) is the subject of some dispute and is discussed in detail on p. 71.

I have not had the opportunity to examine any *Barbus* specimens from Mozambique north of the Zambezi so it is possible that the range of *Barbus oxyrhynchus* may extend further south.

DIAGNOSIS AND AFFINITIES. *Barbus oxyrhynchus* is closely related to *Barbus bynni*, *Barbus gananensis* and *Barbus longifilis* and the points of differences between *Barbus oxyrhynchus* and the three other species will be found on pp. 36 and 129.

Comments on clinal phenomena within this group of species and exemplified by *Barbus oxyrhynchus* are found on p. 129.

## ***Barbus pagenstecheri*** Fischer 1884

*Barbus pagenstecheri* Fischer, 1884, *Jb. hamb. wiss. Anst.* **1** : 30 ; Pfeffer, 1896, *Thierw. O.-Afr. Fische* **5** : 65 ; Boulenger, 1911, *Cat. Afr. Fish* **2** : 72.

LECTOTYPE. The original description was based on two specimens (Nos. H341 and H342 in the Hamburg Museum of 315 and 217 mm S.L. respectively). Boulenger (1911a) redescribed the species on the basis of the smaller specimen and implied that this specimen was the lectotype (he used the word 'type' and mentioned that a larger specimen had also been referred to this species). Ladiges *et alii* (1958), in a non-revisional work, designated the larger specimen (H341) as the lectotype. Here I follow Boulenger in accepting the smaller specimen as the lectotype and regarding the larger specimen as the paralectotype.

DESCRIPTION. The description is based on the only two specimens referred to this species. The morphometric data are shown below and in each case the lectotype comes first. L = 217, 315 mm ; D = 26·3, 29·8 ; H = 24·0, 30·8 ; I = 6·4, 4·8 ; IO = 7·4, 10·2 ; MW = 6·9, 8·9 ; Pct = 20·3, 24·8 ; CPl = 17·5, 17·5 ; CPd = 10·1, 12·3 ; Snt = 6·9, 9·8 ; Ab = 4·1, 5·1 ; Pb = 5·2, 6·4.

Unless otherwise stated all measurements are expressed as percentages of the standard length.

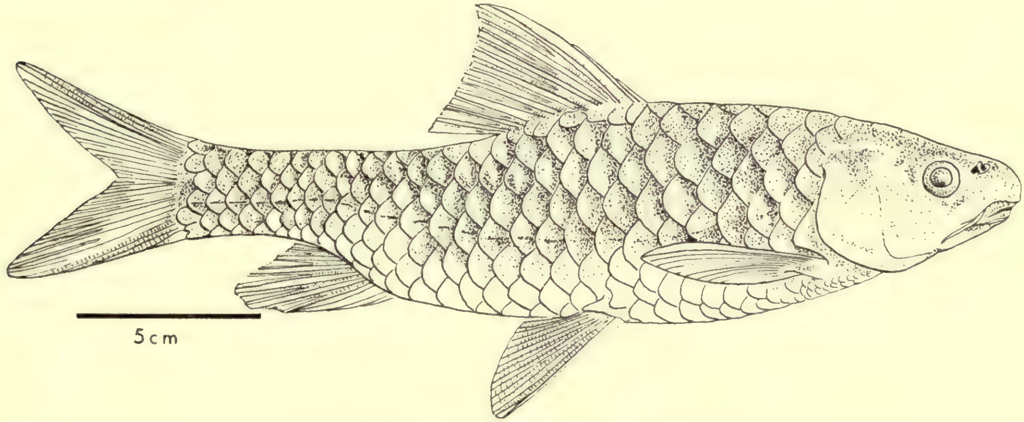

FIG. 84. *Barbus pagenenstecheri* lectotype.

The body (fig. 84) is elongated, the dorsal profile rises gradually and smoothly from the snout to the origin of the dorsal fin. The caudal peduncle is about half as long again as it is deep. The mouth is sub-terminal with a sharp edge to the lower jaw in the lectotype but rubber lips are developed in the paralectotype. The snout is blunter in the lectotype than in the paralectotype. Both specimens have a clearly defined rostral groove. Numerous small tubercules are present on the snout and the cheeks of both specimens.

*Squamation.* There are 26 or 27 scales in the lateral line series, 4·5 (f.2) scales between the dorsal mid-line and the lateral line, 4·5 (f.2) scales between the lateral line and the ventral mid-line and 2·5 (f.2) scales between the lateral line and the

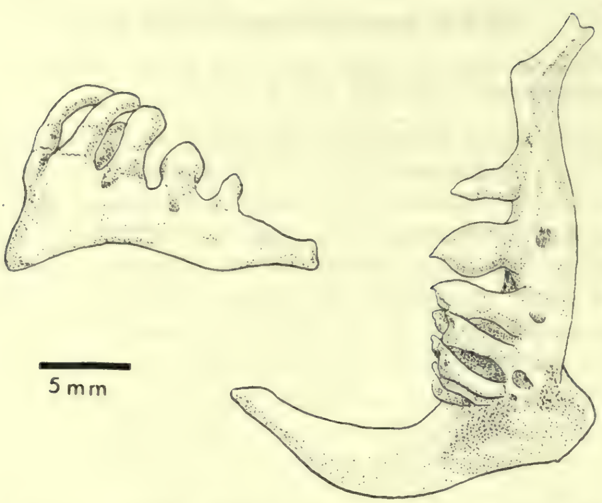

FIG. 85. *Barbus pagenenstecheri* – dorsal and lateral views of the left pharyngeal bone.

base of the pelvic fin. Twelve scales encircle the caudal peduncle. The exposed parts of the scales bear numerous, sinuous, more or less parallel striae.

*Dorsal fin.* There are four unbranched rays and eight branched rays in the dorsal fin. The last unbranched ray is weakly ossified into a smooth spine, 14·3, 13·7 per cent S.L. The dorsal margin of the fin is slightly concave. The dorsal fin origin is slightly in advance of the pelvic fin origin.

The *anal fin* has three unbranched rays and five branched rays.

*Pharyngeal bones and teeth.* Pharyngeal bones are present only in the paralectotype. The pharyngeal teeth number 2.3.5.–5.3.2. The teeth are widely spaced (fig. 85). The lateral flange is confined to the angle ot the bone level with the fourth and fifth teeth of the inner row.

*Gill rakers.* There are 12 or 15 gill rakers on the lower limb of the first gill arch.

*Coloration.* The colour of alcohol-preserved specimens is dark brown on the back paling to yellow-brown on the ventral surface. The edges of the scales on the back and dorsal part of the flanks are lighter than the centres. The fins are dark grey-brown.

DISTRIBUTION. Fischer (1884) collected the fish from a stream flowing down Mount Kilimanjaro. Bailey (1969) gives the locality as in the Pangani system. There is no evidence for this because only the streams on the south face of Mount Kilimanjaro flow into the Pangani. The streams on the eastern face flow into the Tsavo river whilst the streams on the northern and western faces have no outlet to the sea. All of the streams are covered by the locality description 'German East Africa'. Detailed information on the expeditions' collecting sites is lacking.

DIAGNOSIS AND AFFINITIES. *Barbus pagenstecheri* is a species of uncertain affinities, its distribution is localized and it is surrounded by waters containing *Barbus* *oxyrhynchus.* I have not seen any specimens, nor have I been able to find any reliable records, of *Barbus oxyrhynchus* from the Kilimanjaro region and it is therefore possible that the two specimens referred to *Barbus pagenstecheri* may represent a local population of *Barbus oxyrhynchus.* The differences between these two fishes and equal-sized specimens of *Barbus oxyrhynchus* are marked. The former fishes have shallow bodies and weak dorsal spines whilst the latter have deeper bodies and strong dorsal spines. The lateral line scale count in *Barbus pagenstecheri* is at the upper end of the *Barbus oxyrhynchus* range and the scale striations are similar in both species. *Barbus mariae* from the Athi river can easily be distinguished from *Barbus pagenstecheri* by its 'rhinoceros horn' (see p. 84). With only two specimens available it is, I feel, preferable to maintain the species *Barbus pagenstecheri* rather than to regard these specimens as local variants of *Barbus oxyrhynchus.* Further collections from the Kilimanjaro region are needed to reach a satisfactory conclusion.

## ***Barbus paucisquamatus*** Pellegrin 1935

*Barbus altianalis* var. *labiosa* (part) Pellegrin, 1933, *Bull. Soc. zool. Fr.* **58** : 169 (only the paratype, from Loama).

*Barbus altianalis* var. *paucisquamata* Pellegrin, 1935, *Revue Zool. Bot. afr.* **27** (3) : 378.

*Barbus altianalis* var. *longifilis* (part) Pellegrin, 1935, *Revue Zool. Bot. afr.* **27** (3) : 378 (only the specimen from Nyabarongo).

*Barbus altianalis* var. *lobogenysoides* Pellegrin, 1935, *Revue Zool. Bot. afr.* **27** (3) : 380.

NOTES ON THE SYNONYMY. The specimens of the varieties of *Barbus altianalis* described by Pellegrin (*op. cit.*) which came from rivers in the Congo system constitute a species distinct from *Barbus altianalis.*

The name *labiosa,* although the oldest infra-specific name, is not available for this newly defined species as the holotype of that variety (a fish from Lake Kivu) is a specimen of *Barbus altianalis altianalis.* The type series of *Barbus altianalis* var. *paucisquamata* is homogeneous and the infra-specific name *paucisquamata* (when the gender is changed to form *paucisquamatus* – Article 30) is available and is used accordingly.

There are certain inaccuracies in the original description of the specimens of *Barbus altianalis* var. *paucisquamata.* Pellegrin (1935 : 379) lists three specimens of lengths 130 + 35 = 165, 140 + 40 = 180, 130 + 35 = 165. The measurements presumably refer to the standard length, 'tail fin' length and the total length. The three syntypes (Paris Museum Nos. 35-76, 35-77, 35-78 are of 124, 164 and 116 mm S.L. respectively. M.A.C.T. specimen 42932 is registered as a 'co-type', there is a label with this fish saying 'co-type, don. de Mus. Paris Loc. Kivu, réc. Guy Babault'. This fish is of 177 mm S.L.

LECTOTYPE. Specimen 35-76 in the Paris Museum is designated the lectotype. This specimen of 124 mm S.L. is closest in size to any of the Pellegrin measurements. It is also the only specimen with a precise locality which is Kitembo, Nyabarongo river.

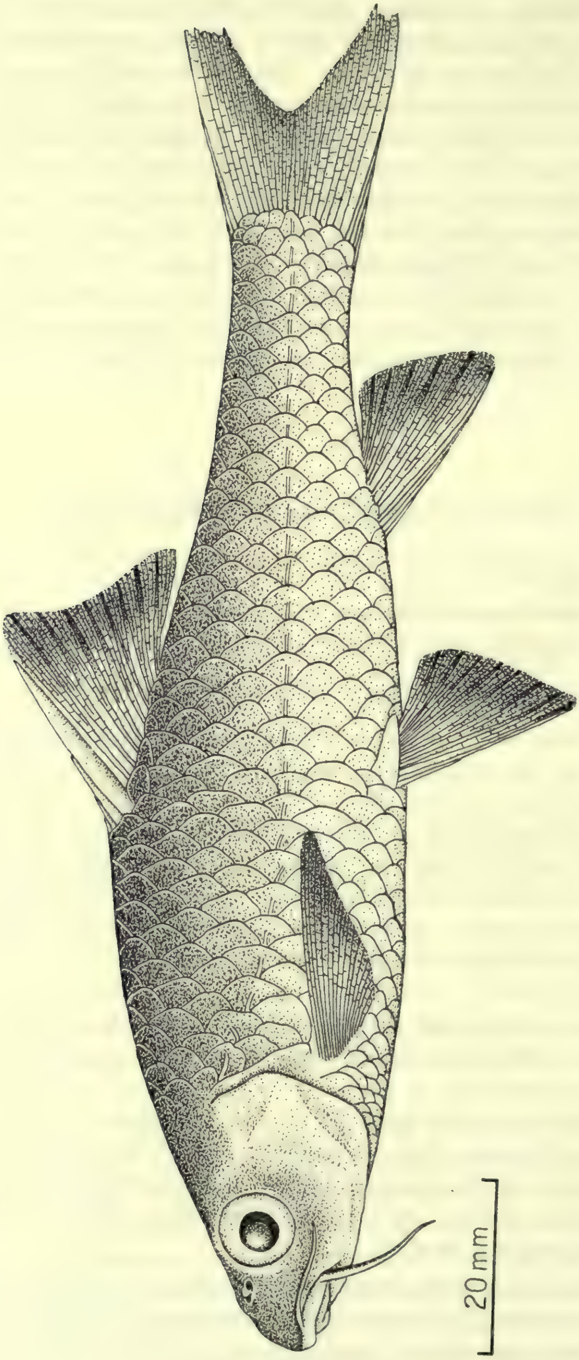

Fig. 86. *Barbus paucisquamatus* lectotype.

DESCRIPTION. The description is based on 12 specimens from 80 to 248 mm S.L.

| | x̄ | s.d. | s.e. | range |
|---|---|---|---|---|
| L | | | | 80 –248 mm |
| D | 26·8 | 1·6 | 0·5 | 24·0–30·0 |
| H | 25·5 | 1·3 | 0·4 | 23·8–27·6 |
| I | 7·2 | 1·2 | 0·3 | 5·4– 9·4 |
| IO | 7·6 | 0·9 | 0·2 | 6·3– 8·5 |
| MW | 5·8 | 0·4 | 0·1 | 5·2– 6·2 |
| Pct | 21·2 | 0·9 | 0·3 | 20·2–22·8 |
| CPl | 18·0 | 1·2 | 0·3 | 16·4–19·7 |
| CPd | 11·0 | 1·0 | 0·3 | 9·4–13·0 |
| Snt | 8·0 | 0·9 | 0·3 | 6·8– 9·3 |
| Ab | 7·5 | 1·4 | 0·4 | 5·8–10·6 |
| Pb | 8·6 | 1·7 | 0·4 | 6·2–11·2 |

All measurements are expressed as percentages of the standard length. The body is compressed. The dorsal profile of the snout is curved, the ventral profile is flat. The mouth is ventral and horse-shoe shaped. The lower lip is well defined and varies between continuous with a slight mental lobe and medially discontinuous. The upper lip forms the ventral edge of the snout. The barbels are conspicuously long.

*Squamation.* The lateral line has 27 (f.3), 28 (f.4) or 29 (f.5) scales. Between the dorsal mid-line and the lateral line there are 4·5 (f.12) scales. Only seven specimens were in sufficiently good condition for the scales between the lateral line and the ventral mid-line to be counted; five specimens have 4·5 scales and two specimens have 5·5 scales. Two and a half scales are present between the lateral line and the pelvic fin insertion. There are 12 scales around the caudal peduncle. The striae on the scales are numerous and more or less parallel. The striae of scales on the upper part of the body tend to diverge slightly whilst scales on the lower part of the body tend to have striae that are parallel or slightly converging.

*Dorsal fin.* The dorsal fin has four unbranched rays, the last one is ossified into a smooth, straight or slightly curved spine (x̄ = 19·7; s.d. = 2·7; s.e. = 0·8; range 14·1–22·5). There are nine (f.11) or eight (f.1) branched rays. The dorsal margin of the fin is only very slightly concave. The origin of the dorsal fin is in front of the origin of the pelvic fins.

*Pharyngeal bones and teeth.* No exceptions to the pharyngeal tooth formula 2.3.5.–5.3.2. were found. The teeth are shown in fig. 87. The anterior edentulous process has its distal half at an angle to the proximal half.

*Gill rakers.* There are 11 (f.3) or 10 (f.3) on the lower limb of the first gill arch in the six specimens examined.

*Coloration.* All the preserved specimens are dark fish. Dark-brown pigment is present on the distal parts of the dorsal, anal, pelvic and pectoral fins. On the caudal fin the pigment is concentrated at the margins.

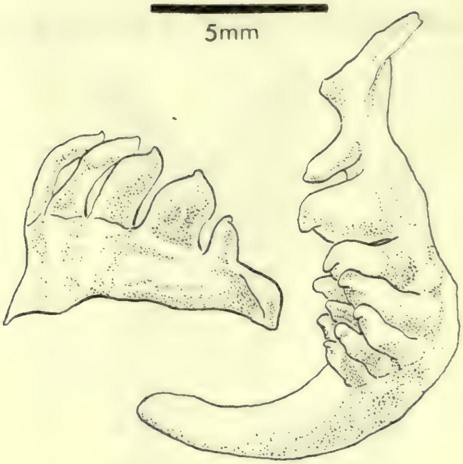

FIG. 87. *Barbus paucisquamatus* – left pharyngeal bone from the lectotype.

The body is dark brown but the scales have a noticeably high reflectivity. The skin of the cheeks and snout has a silvery layer below the brown pigment. The dorso-lateral surface of both barbels, particularly the anterior barbel, is pigmented.

DISTRIBUTION. Known from the Loama river, the Nyabarongo river and the Luhoho Congo.

DIAGNOSIS AND AFFINITIES. *Barbus paucisquamatus* is a fish with 27–29 scales in the lateral line series, dark pigment widespread over the body but not obscuring a very silvery layer beneath and scales on which the striae vary with the position of the scale on the body.

Its affinities are uncertain as there is an absence of clear-cut similarities or distinctions with other species. It is sympatric with *Barbus longifilis* from which it can be distinguished by its shorter barbels, shallower body and weaker dorsal spine.

Although *Barbus paucisquamatus* was described as a variety of *Barbus altianalis*, the caudal peduncle is conspicuously longer and shallower than in that species, and the overall impression gained from the body shape and colour is that there is no close relationship between *Barbus altianalis* and *Barbus paucisquamatus*.

The heavy pigmentation and a similar mouth are also found in *Barbus caudovittatus* (p. 40) but at the moment I do not have enough information to comment further on the possibilities of a relationship between these two species, nor between *Barbus paucisquamatus* and the morphologically somewhat similar *Barbus trachypterus*.

## ***Barbus platyrhinus*** Boulenger 1900

*Barbus platyrhinus* Blgr., 1900, *Ann. Mag. nat. Hist.* (7) **6** : 479.

HOLOTYPE. A fish of 347 mm S.L. from Usamburu, Lake Tanganyika, B.M. (N.H.) Reg. No. 1906.9.6 : 12.

DESCRIPTION. Based upon seven specimens, the holotype and six fishes M.A.C.T. Nos. 89789–92, 130658–60.

| | $\bar{x}$ | s.d. | s.e. | range |
|---|---|---|---|---|
| L | | | | 57 –347 mm |
| D | 29·6 | 2·4 | 0·9 | 26·1–32·3 |
| H | 25·7 | 1·0 | 0·4 | 24·2–27·2 |
| I | 7·2 | 0·9 | 0·4 | 6·3– 9·1 |
| IO | 9·8 | 0·9 | 0·3 | 8·2–10·9 |
| MW | 6·7 | 0·9 | 0·3 | 5·7– 8·1 |
| Pct | 21·4 | 1·3 | 0·5 | 19·6–23·7 |
| CPl | 16·5 | 1·1 | 0·4 | 15·2–18·7 |
| CPd | 12·2 | 0·8 | 0·3 | 10·9–13·7 |
| Snt | 8·8 | 0·6 | 0·3 | 7·6– 9·5 |
| Ab | 3·4 | 0·7 | 0·3 | 2·1– 4·3 |
| Pb | 4·5 | 0·5 | 0·2 | 3·6– 5·2 |

*Barbus platyrhinus* is a heavy-bodied fish, the bulky appearance becoming more exaggerated in larger specimens. The mouth is ventral and the snout has a slightly bulbous profile above the upper jaw.

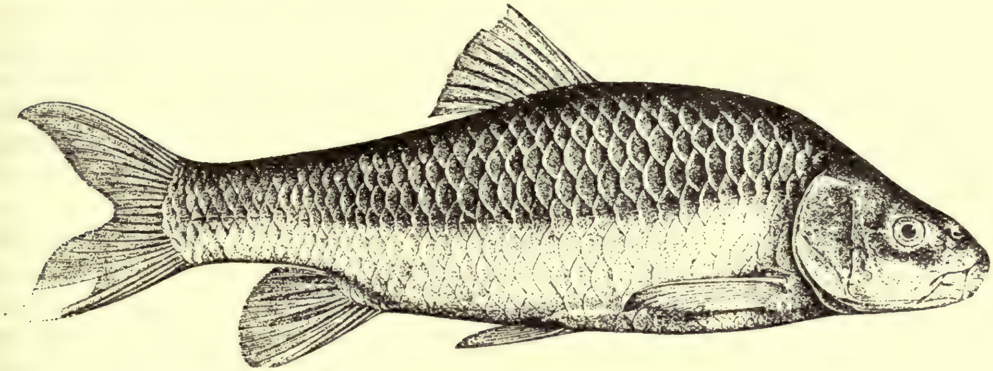

FIG. 88. *Barbus platyrhinus* holotype (from Boulenger 1911a).

*Squamation.* The lateral line follows a fairly straight course. The dip in the middle of the line is shallow. The lateral line scale counts are 38 (f.2), 39 (f.3), 40 (f.1), 41 (f.1). There are 6·5 (f.1) or 7·5 (f.6) scales between the dorsal mid-line and the lateral line. There are 6·5 (f.1), 7·5 (f.2), 8·5 (f.4) scales between the lateral line and the ventral mid-line. There are 3·5 (f.2) or 4·5 (f.4) scales between the lateral line and the base of the pelvic fin. Sixteen (f.3) or 18 (f.4) scales encircle the caudal peduncle, the scales are longitudinally striated.

*Dorsal fin.* The dorsal fin has four unbranched rays. The last unbranched ray ranges from 10·1 to 24·6 per cent S.L. with a mean value of 18·1 per cent. There are 8 (f.1), 9 (f.5) or 10 (f.1) branched rays. The origin of the dorsal fin is slightly in advance of the origin of the pelvic fins.

The *anal fin* has three unbranched rays and five branched rays.

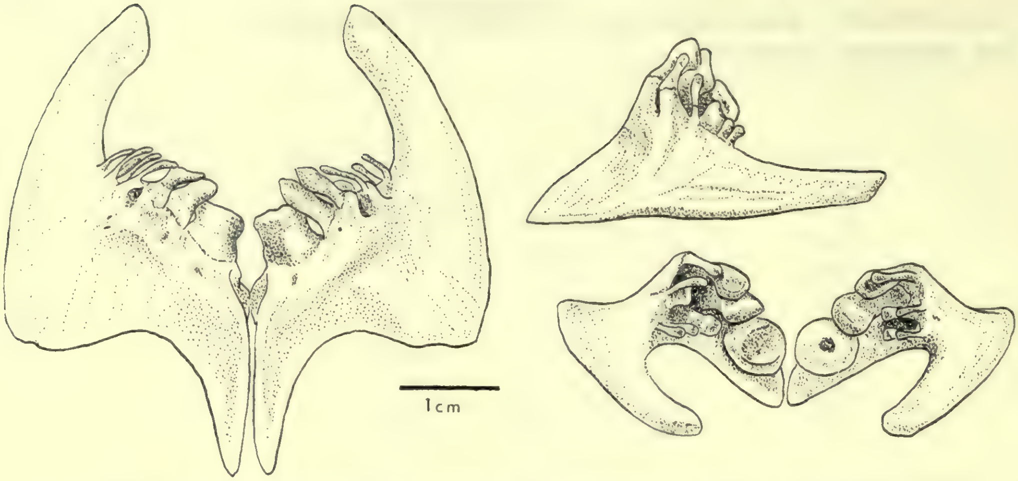

FIG. 89. The pharyngeal bones from the holotype of *Barbus platyrhinus*.

*Pharyngeal bones and teeth.* The only pharyngeal bones that I have been able to examine are from the holotype and are apparently aberrant (fig. 89); the pharyngeal formula is 4.3.2. The inner row lacks the first tooth present in other species, the first tooth present in *Barbus platyrhinus* is the homologue of the usual second tooth and is referred to as the second tooth. The second tooth is large and molariform. The third tooth has a rounded crown wider than long with a slight concavity in the posterior face of the left-hand tooth and a deep concavity in the anterior face of the right-hand tooth. The fourth tooth is smaller than the preceding, the anterior edge of the crown is its highest point and the posterior face is concave. This tooth is wider than it is long. The fifth tooth is slight and its spatulate crown is very close to the preceding crown. On the left-hand bone the first tooth of the middle row is missing but the scar is present. Its counterpart is mamilliform and wider than long. It is physically closer to the anterior tooth of the dorsal row than to the second tooth of the middle row. The second and third teeth become progressively smaller. They are complete on the left-hand bone but either aberrant or in the process of being replaced on the right-hand bone. The two small teeth in the outer row are wider than long with a concave posterior face.

The pharyngeal bones themselves are short and thick.

There are between 11 and 13 broad, bilobed *gill rakers* on the lower part of the first gill arch.

DISTRIBUTION. This species has been recorded at Usamburu and Uvira, Lake Tanganyika and from the Koki river, an affluent of Lake Tanganyika. Poll (1953) believes that it is rare in the lake and may be commoner in the affluent rivers.

DIAGNOSIS AND AFFINITIES. This species is sympatric with *Barbus tropidolepis* to which, at the very least, it is closely related. Both species have a high number of lateral line scales and similarly shaped pharyngeal teeth. The major difference between them is the development of the fatty ridges on the scales in *Barbus tropidolepis* and the universal presence of barbels in *Barbus platyrhinus*. A larger series of specimens of this species and some information on their ecology may show that they are not a valid species, but for the moment it must be retained as there is, in some characters, no overlap. I have not yet found any fish which cannot with certainty be placed in either *Barbus platyrhinus* or *Barbus tropidolepis*, but the specimens examined have been few in number. The possibility that *Barbus platyrhinus* is a hybrid must also be borne in mind.

### ***Barbus ruasae*** Pappenheim and Boulenger 1914

*Barbus ruasae* Pappenheim and Blgr., 1914, *Wiss. Ergebn. dt. ZentAfr. Exped.* Zool. (3) **5** : 238, pl. 2, fig. 2.

LECTOTYPE. The lectotype is the smaller of the two type specimens of Pappenheim & Boulenger, a fish of 155 mm total length and 126 mm S.L. This is the specimen figured by the authors. The lectotype and paralectotype (a fish of 128 mm S.L.) are in the Zoological Museum, Berlin, both registered as ZMB 19053. The locality is Mkunga in Rwanda.

DESCRIPTION. The description is based on five specimens, the two from Mkunga (see above) and three specimens, M.A.C.T. Nos. 91755, 91756, 92214, from the Nyabugogo, an affluent of the Lusine about 64 km SSE of the type locality.

| | $\bar{x}$ | s.d. | s.e. | range |
|---|---|---|---|---|
| L | | | | 103 –135 mm |
| D | 25·6 | 1·6 | 0·7 | 23·7–28·1 |
| H | 27·0 | 0·9 | 0·4 | 25·8–28·1 |
| I | 8·6 | 0·6 | 0·3 | 8·0– 9·7 |
| IO | 7·3 | 0·3 | 0·1 | 7·0– 7·8 |
| MW | 6·5 | 1·0 | 0·4 | 5·6– 8·0 |
| Pct | 21·8 | 2·2 | 1·0 | 18·3–23·4 |
| CPl | 16·2 | 1·3 | 0·6 | 14·7–18·4 |
| CPd | 10·6 | 0·5 | 0·2 | 10·1–11·5 |
| Snt | 8·4 | 0·5 | 0·2 | 7·8– 8·9 |
| Ab | 5·3 | 1·7 | 0·7 | 2·4– 7·1 |
| Pb | 6·1 | 1·8 | 0·8 | 3·2– 8·0 |

All measurements are expressed as a percentage of the standard length. The mouth is ventral, the anterior margin of the lower jaw is curved and the upper and lower lips developed but not lobed. The barbels in the lectotype show signs of damage. The head is pointed, the dorsal margin of the body rises in a smooth curve from the snout to the origin of the dorsal fin. The lateral line count is 25 (f.9) or 26 (f.1) (both sides of the fish considered). The smallest of the M.A.C.T. specimens has the count of 26 on one side. There are 4·5 scale rows between the dorsal mid-line and the lateral line and 4·5 from there to the ventral mid-line. Two and a half scales are between the lateral line and the base of the pelvic fin and 12 scales

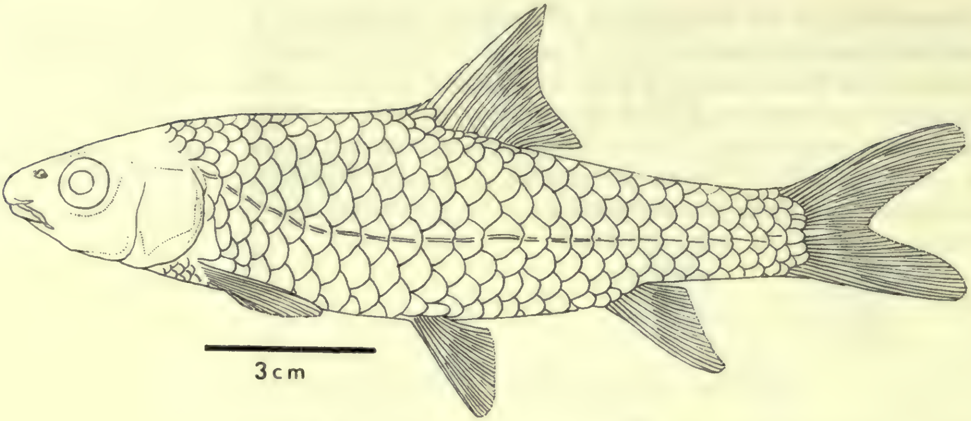

FIG. 90. *Barbus ruasae* lectotype.

encircle the caudal peduncle. The striae on the scales are parallel and much wider apart on the scales of the pectoral region than on the scales of the caudal peduncle. The dorsal fin has four unbranched rays, the last is ossified into a strong smooth spine ($\bar{x}$ = 21·0 ; s.d. = 2·9 ; s.e. = 1·3 ; range 18·6–26·0). There are 8 (f.2), 9 (f.2) or 6 (f.1) branched rays. The dorsal fin with six branched rays showed obvious signs of damage. The origin of the dorsal fin is above or slightly anterior to the origin of the pelvic fin. A low sheath of scales surrounds the base of the dorsal fin.

The *anal fin* has three unbranched and five branched rays.

*Pharyngeal bones and teeth.* The pharyngeal bones are moderately slender, the teeth are in three rows of 5.3.2. on each bone. The second tooth in the inner row of the largest M.A.C.T. specimen (No. 992214) is more molariform than in the lectotype.

There are from 10 to 13 *gill rakers* on the lower limb of the first gill arch.

*Coloration.* In alcohol the fish present a silvery appearance. The back is a mid-brown which shades to silver on the belly. The centres of the scales are bright silvery and the edges are darker. Traces of dark pigment remain in the middle of the caudal fin, the distal edge of the dorsal fin, the anal fin and the posterior margins of the pectoral and pelvic fins.

DIAGNOSIS AND AFFINITIES. *Barbus ruasae* is a member of the *Barbus intermedius* complex and as such it is compared with and distinguished from *Barbus acuticeps* on p. 8, *Barbus altianalis* on p. 27 and *Barbus intermedius* on p. 140.

Pappenheim & Boulenger (*op. cit.*) thought, prophetically, that *Barbus ruasae* showed affinities to *Barbus leptosoma* (= *Barbus intermedius*).

Very low lateral line counts are found in *Barbus mawambiensis*. This species is found in the not-too-distant Ituri and Ja rivers which although in the Congo system do not flow into the Lake Victoria basin. I do not have enough information to determine whether or not there is any relationship between *Barbus ruasae* and *Barbus mawambiensis*.

My knowledge of the *Barbus* species of the Congo is insufficient to even hazard any opinions on the relationships of the species concerned.

## *Barbus somereni* Boulenger 1911

*Barbus somereni* Blgr., 1911, *Ann. Mag. nat. Hist.* (8) **8** : 369 ; Greenwood, 1966, *The Fishes of Uganda* 2nd ed. : 69 ; Banister, 1972, *Bull. Br. Mus. nat. Hist.* (Zool.) **24** (5) : 261–290.
*Barbus altianalis urundensis* David, 1937, *Revue Zool. Bot. afr.* **9** (4) : 414.
*Barbus urundensis* Poll, 1946, *Annls. Mus. r. Congo Belge* (1) **4** (3) : 185–188.

HOLOTYPE. A fish of 172 mm S.L., B.M. (N.H.) Reg. No. 1911.7.26 : 1 from the Sibwe river, Ruwenzori mountains, Uganda.

DESCRIPTION. The description is based on 51 specimens, 66–279 mm S.L. All measurements are expressed as percentages of the standard length.

| | x̄ | s.d. | s.e. | range |
|---|---|---|---|---|
| D | 29·5 | 2·9 | 0·4 | 25·4–38·4 |
| H | 29·9 | 1·4 | 0·2 | 21·6–28·8 |
| I | 7·6 | 1·4 | 0·2 | 5·2–10·6 |
| IO | 8·5 | 1·1 | 0·1 | 6·7–11·7 |
| MW | 7·5 | 0·8 | 0·1 | 6·3– 9·2 |
| Pct | 22·2 | 1·7 | 0·2 | 18·4–28·0 |
| CPl | 16·3 | 1·3 | 0·2 | 13·9–19·0 |
| CPd | 11·6 | 0·7 | 0·1 | 10·4–13·2 |
| Snt | 8·6 | 0·6 | 0·1 | 7·6–10·2 |
| Ab | 7·8 | 1·0 | 0·1 | 5·6– 9·6 |
| Pb | 8·6 | 1·2 | 0·2 | 6·3–11·6 |

The body is slightly compressed and becomes relatively deeper in larger fishes. This and the relative decrease in the diameter of the eye with an increase in the

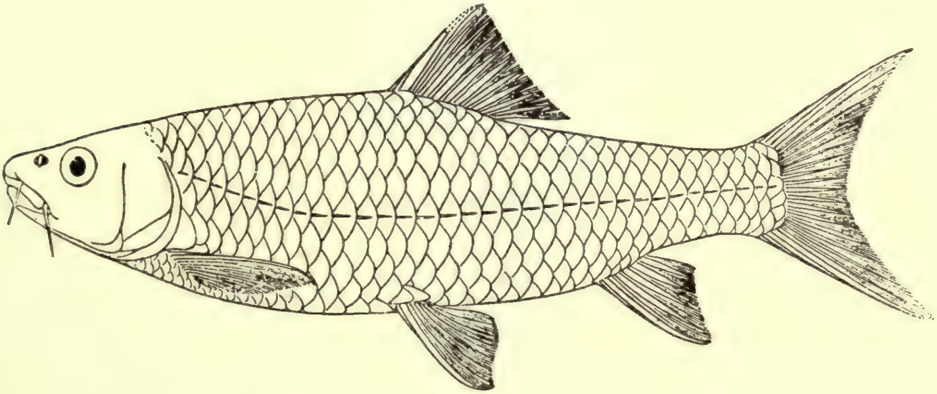

FIG. 91. *Barbus somereni* holotype (from Boulenger 1916).

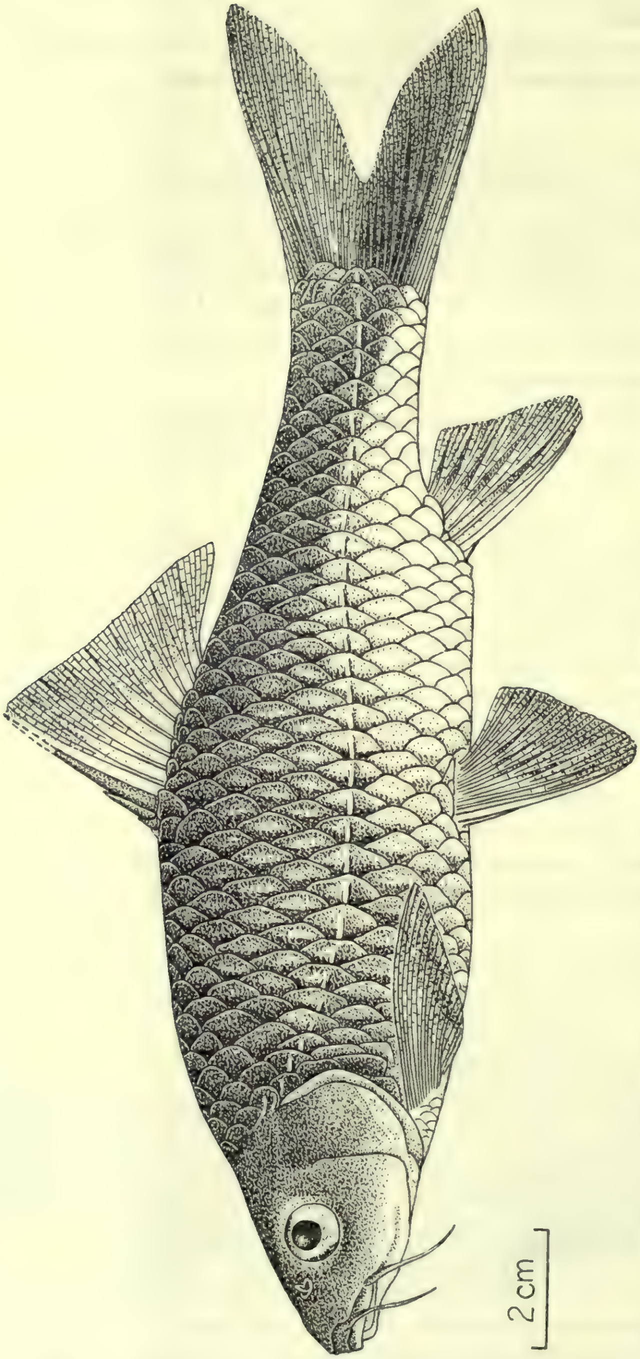

FIG. 92. A specimen of ***Barbus somereni*** from the Sibwe river, Uganda, displaying the typical features of the species and the colour pattern which is not shown on the holotype.

standard length are the only obvious signs of allometric growth. In the other measurements, the scatter of the points precludes the determination of the direction of the allometry.

The mouth is sub-inferior and usually has continuous, moderately developed lips, but a 'rubber-lipped' specimen was collected in the Sibwe river.

Three fish from the Malagarasi river were described by David (1937) as *Barbus altianalis urundensis.* I find that her three syntypes (M.A.C.T. Reg. Nos. 46963–46965) have IV–8 (f.1), IV–9 (f.2) rays in the dorsal fin (not III–9 as described) and have 31 (f.1), 32 (f.1), 33 (f.1) scales in the lateral line. Her counts were of the total number of scales.

*Squamation.* The number of scales in the lateral line ranges from 26 to 34: 26 (f.1), 27 (f.2), 28 (f.3), 29 (f.5), 30 (f.11), 31 (f.12), 32 (f.7), 33 (f.7), 34 (f.1).

The pattern of striae on the scales varies between that which is regarded as typically radiate and that which is typically parallel. There is a general tendency for the shoulder scales in this species to be of the latter type and the belly scales to be of the former. The striae are, however, more numerous than is usual for the classical radiately striated *Barbus* (see fig. 93).

There are 5·5 (sometimes 4·5 rarely 6·5) scales between the dorsal mid-line and the lateral line and 4·5–6·5 (rarely 7·5) scales between the lateral line and the ventral mid-line. The specimens from the Sibwe and Tokwe rivers (Lake George affluents) have 3·5 scales between the lateral line and the pelvic fin, whilst those from Mahembe and the Mutamphu river (Kagera system) have 2·5 scales (rarely 2 or 3).

There are 12 scales round the caudal peduncle.

*Dorsal fin.* There are four unbranched rays, the last is ossified with a smooth posterior margin. This is also true for the type specimen although Boulenger (1911b) describes only three unbranched rays. The length of the last unbranched ray varies from 8·7 to 21·2 per cent of the standard length ($\bar{x}$ = 13·8). There are nine or ten branched rays except in one fish where there are eight.

The *anal fin* has three unbranched and five branched rays.

*Coloration.* The ripe-running males in the Sibwe river have a deep olive-brown back which changes sharply into an ochrous yellow colour on the flanks and belly. The dark olive on the back is continued into the lower lobe of the caudal fin. The upper caudal lobe and the dorsal fin are pale brown. This pattern of a dark back and dark lower caudal lobe persists in fishes which are sexually inactive and is also visible in the great majority of preserved specimens.

*Gill rakers.* There are 8–11 gill rakers on the lower limb of the first arch. The rakers are bilobed with the sharply triangular outer lobe the larger.

*The pharyngeal bones and teeth.* The teeth are slightly hooked with no significant enlargement or molarization of the second tooth on the inner row (fig. 94). The pharyngeal tooth formula is 2.3.5.–5.3.2.

DISTRIBUTION. Specimens are known in the Ruwenzori area from the following rivers: Sibwe river, Mubuku river, Tokwe river and Kirimia river. In the Sibwe and Mubuku rivers which flow into the northern end of Lake George, *Barbus somereni*

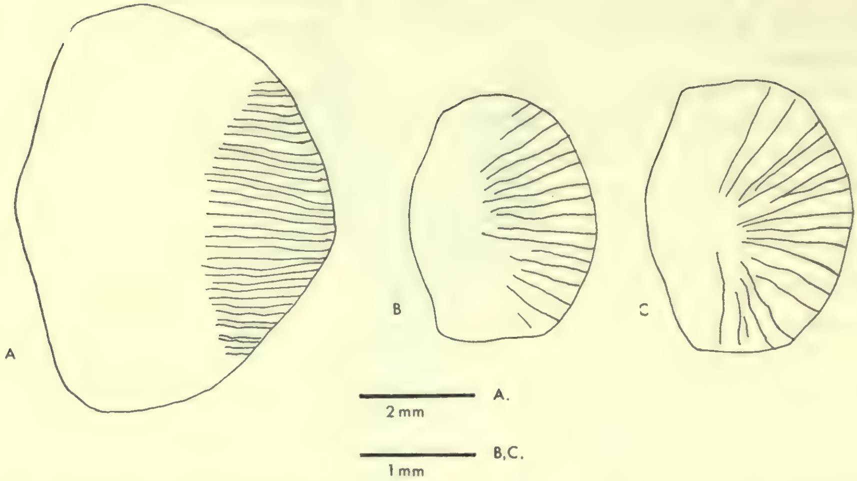

FIG. 93. Scales from the shoulders of A) *Barbus bynni*, B) *B. somereni*, C) *B. humilis* to compare the striae on the *B. somereni* scales with the typically 'parallel' and 'radiate' striae patterns shown by the other two species.

lives in the faster-flowing reaches before the rivers meander into the lake. Greenwood (1966) gives 5500 feet as the upper limit of *Barbus somereni* distribution. *Barbus somereni* is not common in the Mubuku river (see Banister 1972).

*Barbus somereni* has also been found in the Nyawarongo (at Mahembe) and Akianaru (Rwanda) rivers, in the Mutamphu river (12 km from Astrida on the road to Shangugu), in the Chirangobwe river (Lake Kivu basin), Mwogo river (Kagera system), upper Malagarasi river (Burundi), Kitenge river (Ruzizi) and from the Nyamagana and Nyakagunda rivers (Burundi).

DIAGNOSIS AND AFFINITIES. The relationship between *Barbus somereni* (and its relative *Barbus mirabilis*) and the other African *Barbus* species is uncertain. The body shape, the last simple dorsal fin ray, the number of dorsal fin rays, the nature of the striae on the scales and the colour pattern are all points of difference between *Barbus somereni* and the members of the *Barbus bynni* and *Barbus intermedius* complexes (especially *Barbus altianalis*), which are the closest groups geographically.

*Barbus somereni* is a species which lives at higher altitudes than, for example, *Barbus altianalis eduardianus* in the Lake George–Ruwenzori Mountain region. This could suggest that *Barbus somereni* has been displaced by *Barbus altianalis* and, if so, then *Barbus somereni* is a longer established resident of the area. This view is strengthened by the presence of *Barbus mirabilis* on the other side of the rift valley.

*Barbus somereni* is possibly related to *Varicorhinus ruwenzorii*. These two species live in the same area, have the same colour pattern and it is suggested (Banister 1972) that they hybridize.

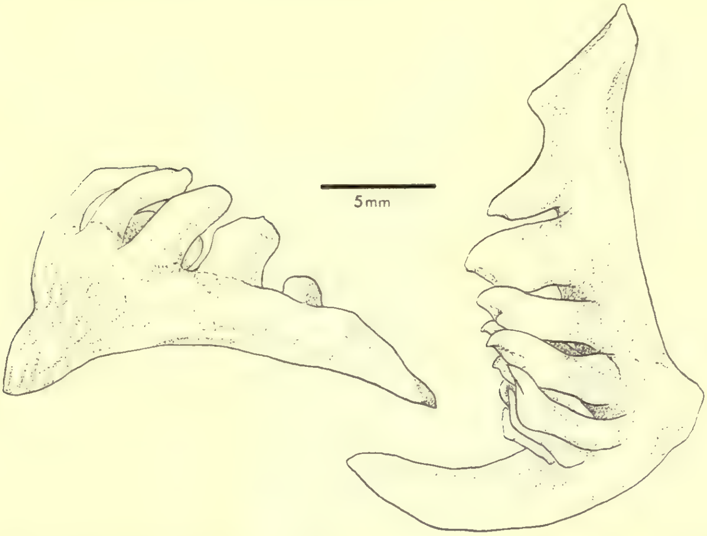

FIG. 94. The dorsal and lateral aspects of the left pharyngeal bone from *Barbus somereni*.

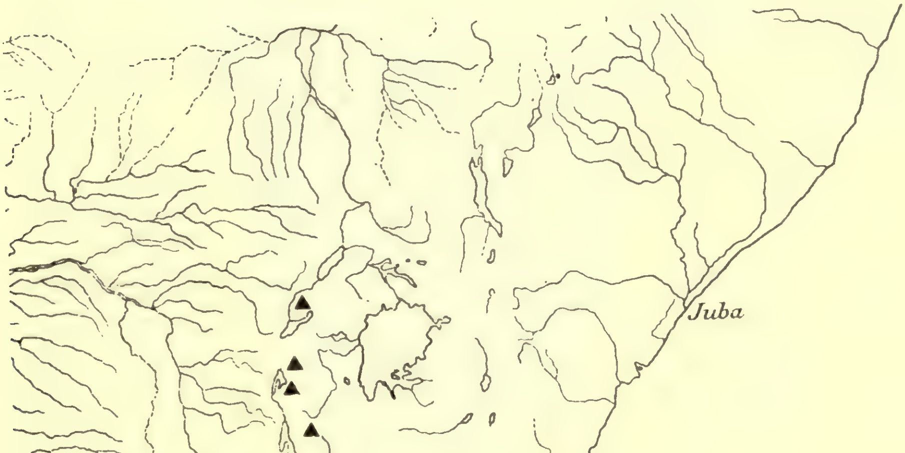

FIG. 95. A map of the distribution of *Barbus somereni*.

### *Barbus stappersii* Boulenger 1915

*Barbus stappersii* Blgr., 1915, *Revue zool. afr.* **4** (2) : 165 ; Blgr., 1920, *Revue zool. afr.* **8** (1) : 13 ; Jackson, 1961, *Fishes of Northern Rhodesia* : 57.

*Barbus curtus* Blgr., 1915, *Revue zool. afr.* **4** (2) : 165 ; Blgr., 1920, *Revue zool. afr.* **8** (1) : 14 ; Jackson, 1959, *Occ. Pap. natn. Mus. Sth. Rhod.* No. 23B : 298 ; Soulsby, 1960, *Nth. Rhod. J.* **4** (4) : 329, fig. 10.

*Barbus oxycephalus* Blgr., 1915, *Revue zool. afr.* **4** (2) : 165 ; Blgr., 1920, *Revue zool. afr.* **8** (1) : 15 ; Soulsby, 1960, *Nth. Rhod. J.* (4) : 329, fig. 11.

*Barbus moeruensis* Pellegrin, 1922, *Revue zool. afr.* **10** (3) : 273 ; Pellegrin, 1928, *Annls. Mus. r. Congo Belge* (1) **3** : 42.

NOTES ON THE SYNONYMY. Jackson (1961) synonymized *Barbus curtus*, *Barbus oxycephalus* and *Barbus moeruensis* with *Barbus trachypterus* Blgr. 1915. These four species and *Barbus stappersii* were each described from single specimens, all from Lake Mweru, and all except *Barbus trachypterus* are large fish, respectively their standard lengths are 233 mm, 264 mm, 594 mm, 128 mm and 283 mm.

These nominal species fall into two obvious groups, one with the caudal peduncle as deep as it is long and the other with the caudal peduncle much longer than deep. The former group consists of the types of *Barbus stappersii*, *Barbus oxycephalus*, *Barbus curtus* and *Barbus moeruensis* whilst the latter group contains *Barbus trachypterus*. The caudal peduncle depth is the most trenchant difference between the two groups although there are others. The size difference has had no effect upon the dimensions of the caudal peduncle, a specimen of 112 mm S.L. referable to *Barbus stappersii* has a caudal peduncle deeper than it is long.

*Barbus trachypterus* is considered here to be a valid species and is described on p. 119.

HOLOTYPE. A fish of 283 mm S.L., M.A.C.T. No. 14250, from Lake Mweru.

DESCRIPTION. The description is based on nine specimens ranging from 103 to 594 mm S.L.

| | x̄ | s.d. | s.e. | range |
|---|---|---|---|---|
| D | 35·6 | 3·8 | 1·1 | 30·0–40·7 |
| H | 25·5 | 1·2 | 0·4 | 25·0–28·2 |
| I | 6·6 | 1·3 | 0·4 | 4·1– 8·7 |
| IO | 9·8 | 1·4 | 0·4 | 7·7–12·3 |
| MW | 7·6 | 1·4 | 0·4 | 6·2–10·8 |
| Pct | 24·0 | 2·2 | 0·7 | 18·6–26·0 |
| CPl | 15·1 | 1·4 | 0·5 | 13·0–17·9 |
| CPd | 15·4 | 1·7 | 0·5 | 12·0–17·4 |
| Snt | 9·1 | 0·8 | 0·2 | 8·0–10·8 |
| Ab | 2·7 | 0·9 | 0·3 | 1·8– 3·9 |
| Pb | 3·6 | 0·7 | 0·2 | 2·8– 4·5 |

They are stocky, deep fish with moderately compressed bodies. The ventral profile is gently convex from the mouth to the anal fin whilst the dorsal profile ascends steeply towards the dorsal fin. The mouth is terminal, the lips moderately developed and with a median lobe on the lower lip. All the examined specimens

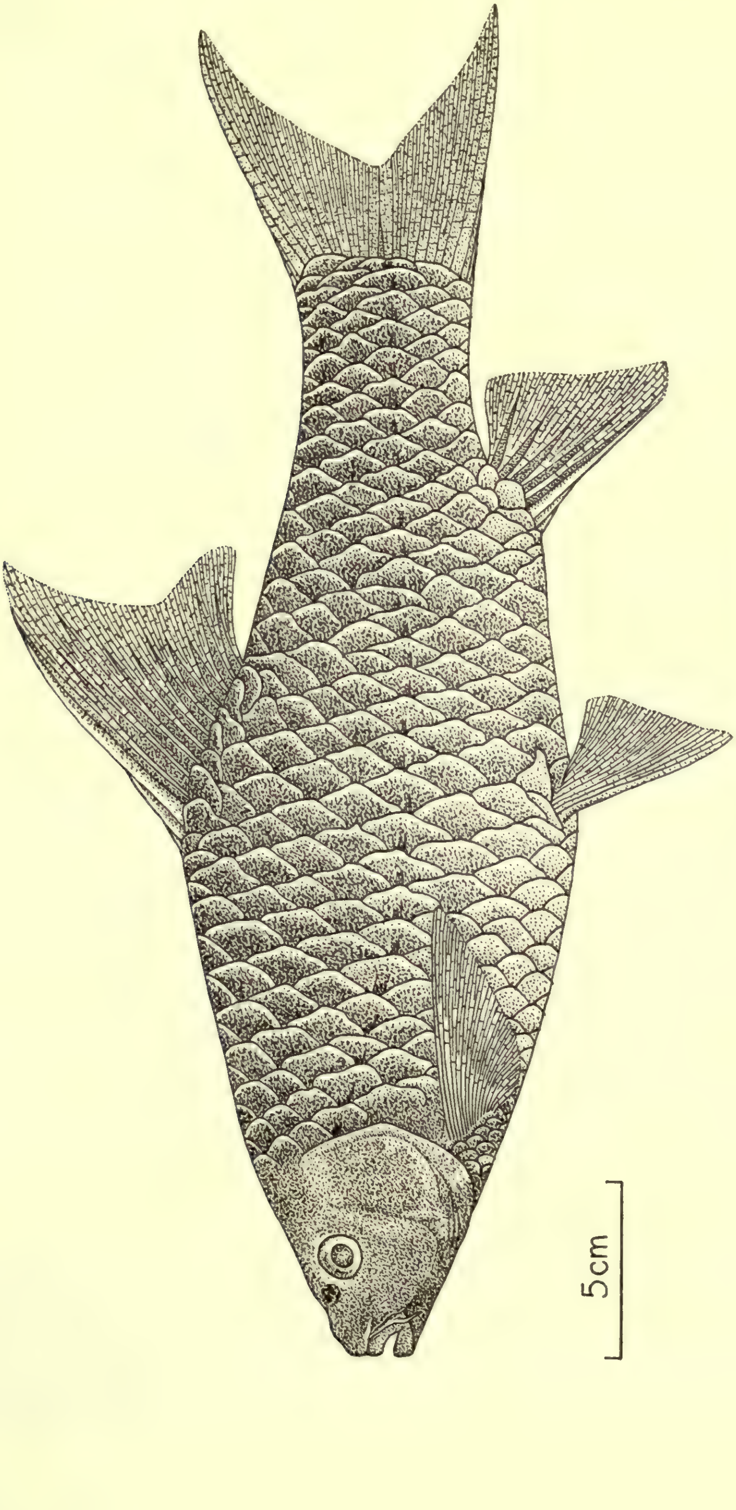

Fig. 96. *Barbus stappersii* holotype.

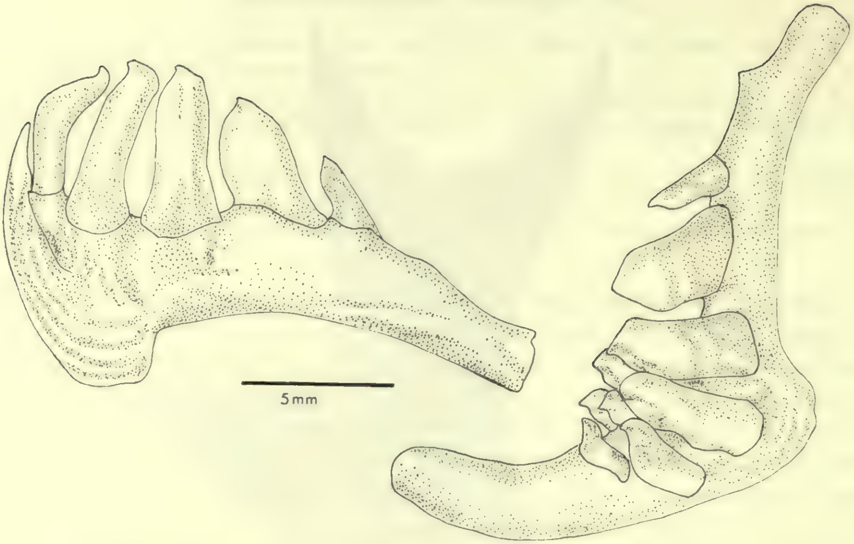

FIG. 97. The dorsal and lateral aspects of the left pharyngeal bone of the holotype of *Barbus stappersii.*

have lips conforming to this pattern, except for a specimen from Kilwa in which the lips are thinner.

The caudal peduncle is as deep as it is long.

*Dorsal fin.* The leading edge of the dorsal fin is slightly in advance of the origin of the pelvic fin. A low basal sheath of scales is present. The anterior edge of the dorsal fin is high and curved so that the concave dorsal margin is positioned almost vertically. The dorsal spine is moderately well ossified, the measurements of the non-flexible basal part in the nine specimens are $\bar{x}$ = 16·0, s.d. = 3·88, s.e. = 1·37 and the range is 9·1 to 21·8 per cent. There are 9 (f.2) or 10 (f.7) branched rays.

The *anal fin* has three unbranched rays and five branched rays.

*Squamation.* The scales have numerous parallel striae. The lateral line has between 23 and 28 scales: 23 (f.1), 24 (f.3), 25 (f.2), 26 (f.1), 27 (f.1), 28 (f.1). There are 4·5 scale rows between the dorsal mid-line and the lateral line and 4·5 (f.8) or 5·5 (f.1) scales between the lateral line and the ventral mid-line. Two and a half scales are present between the lateral line and the pelvic fin base. There are 12 scales around the caudal peduncle.

*Pharyngeal teeth and bones.* The pharyngeal tooth formula is 2.3.5.–5.3.2., the pharyngeal bone (fig. 97) is moderately slender. The crowns of the inner row of teeth are curved. There is little enlargement of the second tooth on the inner row, the first tooth on that row is small with a slightly spoon-shaped crown and it is angled towards the second tooth. The succeeding teeth in that row become higher, more slender and more recurved. The tip of the fifth tooth is hooked forwards.

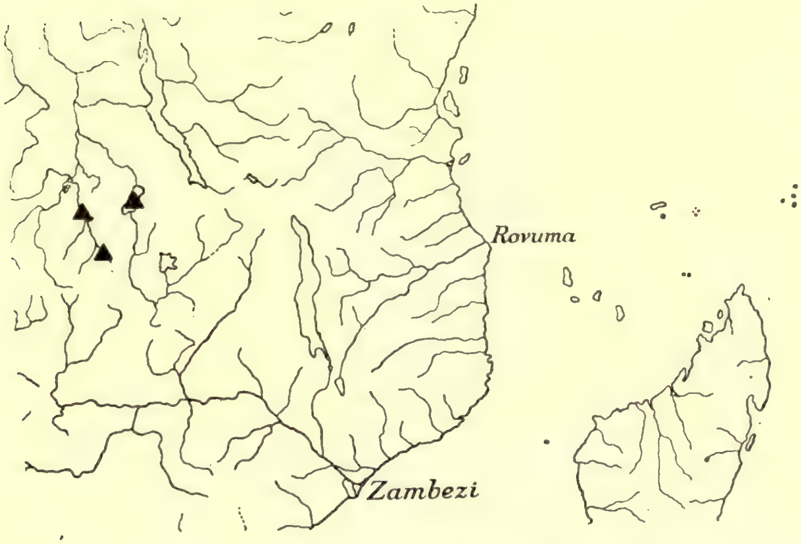

FIG. 98. A map of the distribution of *Barbus stappersii*.

*Gill rakers.* There are 13 curved gill rakers on the lower limb of the first gill arch.

*Coloration.* The colour in alcohol-preserved specimens is uniformly brown, with the centre of each scale a richer, deeper brown than the posterior margin.

DISTRIBUTION. This species is known from Kilwa, on Lake Mweru, and from the Lubumbashi region.

DIAGNOSIS AND AFFINITIES. *Barbus stappersii* is a species easily recognized by its short, deep caudal peduncle, low number of scales in the lateral line series (23–28) and by the high anterior edge of the dorsal fin.

Its affinities are uncertain. In some respects (short, deep caudal peduncle and high dorsal fin) it resembles specimens of *Barbus marequensis* A. Smith from the Zambezi river (the forms described as *Barbus victoriae* Blgr., *Barbus altidorsalis* Blgr., *Barbus chilotes* Blgr., *Barbus codringtonii* Blgr. and *Barbus fairbairnii* Blgr.). A low watershed is the only barrier between the Upper Zambezi and the Lake Mweru basin. Until I have examined more specimens of *Barbus marequensis* and *Barbus stappersii* I am reluctant to comment further on any relationship between these two species.

### **Barbus trachypterus** Boulenger 1915

*Barbus trachypterus* Blgr., 1915, *Revue zool. afr.* **4** (2) : 164 ; Jackson (*partim*) 1961, *Fishes of Northern Rhodesia* : 58.
*Varicorhinus bredoi* Poll, 1948, *Bull. Mus. r. Hist. nat. Belg.* **24** (21) : 9.

HOLOTYPE. A fish of 128 mm S.L., M.A.C.T. No. 11380, from the hydrographical station, Lake Mweru.

DESCRIPTION. The description is based on 17 specimens from 54 to 239 mm S.L.

| | n | x̄ | s.d. | s.e. | range |
|---|---|---|---|---|---|
| L | | | | | 54 –239 mm |
| D | 17 | 27·9 | 1·6 | 0·4 | 25·6–31·4 |
| H | 17 | 25·4 | 2·5 | 0·6 | 21·8–28·8 |
| I | 17 | 5·4 | 1·0 | 0·2 | 3·8– 7·4 |
| IO | 17 | 7·7 | 1·3 | 0·3 | 6·0–11·4 |
| MW | 17 | 6·4 | 0·7 | 0·2 | 5·4– 7·6 |
| Pct | 17 | 21·0 | 1·4 | 0·3 | 18·9–22·6 |
| CPl | 17 | 17·4 | 1·3 | 0·3 | 14·5–19·3 |
| CPd | 17 | 10·7 | 0·9 | 0·2 | 9·1–11·8 |
| Snt | 17 | 8·2 | 1·1 | 0·2 | 6·5–11·4 |
| Ab | 16 | 3·5 | 1·0 | 0·2 | 2·4– 5·5 |
| Pb | 16 | 4·9 | 1·4 | 0·3 | 2·6– 8·0 |

All measurements are expressed as percentages of the standard length.

The body is slightly compressed with a level or gently convex ventral profile and a dorsal profile which rises evenly from the snout to the dorsal fin origin (fig. 99). The mouth is ventral and semi-circular. The upper lip is visible in the ventral view as a thin, fleshy surround to the mouth. The thin rostral flap reaches down to the level of the mouth. The anterior edge of the lower jaw is strongly convex in outline. In small fishes a fleshy lower lip, often with a small mental lobe, is present, but in larger fishes the tendency is for the lower jaw to have a flat, cutting anterior margin. One specimen (M.A.C.T. No. 129097) has well-developed 'rubber lips'.

Tubercles are present on the snout and cheeks of several specimens. The tubercles are comparatively small, but widespread and tend to coalesce. In specimens M.A.C.T. Nos. 165254–165256 they are present on the snout, cheeks, operculum and anal fin rays. They are also present on the anal fin rays of the holotype.

In three comparatively fresh specimens (M.A.C.T. Nos. 165254–165256), the peritoneum is black.

*Squamation.* The scales possess numerous parallel or, at the most, slightly converging striae. There are from 27 to 31 scales in the lateral series: 27 (f.4), 28 (f.4), 29 (f.5), 30 (f.2), 31 (f.2). Twelve scales are invariably present around the caudal peduncle. There are 4·5 (f.15) or 5·5 (f.1) scales between the dorsal mid-line and the lateral line and 5·5 (f.10) or 4·5 (f.3) scale rows between the lateral line and the ventral mid-line except in one specimen (M.A.C.T. No. 129100 of standard length 168 mm) where the scales on the chest are conspicuously reduced. There are 2·5 or 3 scales between the lateral line and the base of the pelvic fins.

*Dorsal fin.* Except for the holotype of *Varicorhinus bredoi* the dorsal fin has four unbranched rays. This specimen now has only two unbranched rays although Poll (1948) records three. There is little doubt that the reduction in the number of simple rays in this specimen is the result of physical damage. The last unbranched ray is ossified into a smooth, often slightly curved spine: x̄ = 20·0; s.d. = 2·48; s.e. = 0·6; range = 16·1–25·0. The dorsal fin is slightly in advance of the pelvic fin origin. There are 8 (f.3), 9 (f.12) or 10 (f.2) branched rays.

The *anal fin* has three unbranched and five branched rays.

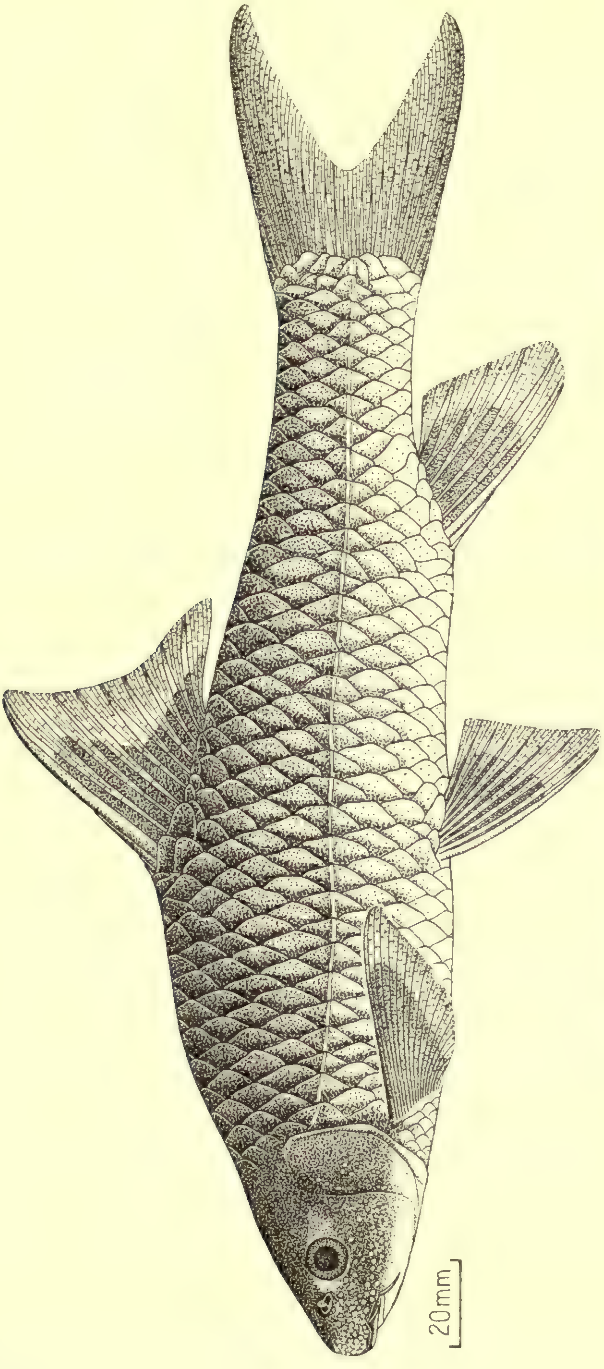

FIG. 99. *Barbus trachypterus*, a specimen from Lake Mweru of 148 mm S.L.

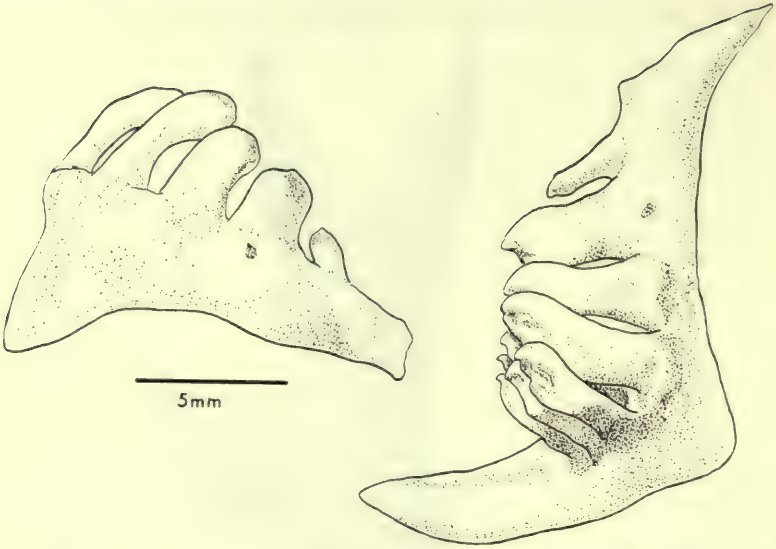

FIG. 100. The dorsal and lateral aspects of the left pharyngeal bone from the figured specimen of *Barbus trachypterus*.

*Pharyngeal bones and teeth.* The pharyngeal tooth formula is 2.3.5.–5.3.2. The pharyngeal teeth are small, slender and crowded (fig. 100). The second tooth of the inner row has a tendency to become molariform; in six of the nine specimens examined the crown is rounded and flattened at the top. The pharyngeal bone is thick and stout, but less so than in *Barbus caudovittatus* specimens of the same size (*cf.* figs. 22 and 23).

*Gill rakers.* The gill rakers number between 11 and 13 on the lower arm of the first gill arch.

*Coloration.* The colour pattern is invariably different from that of *Barbus caudovittatus* with which some of these specimens have been confused. The black upper half of the sides are mid-brown with darker brown bases to the scales. The lower part of the flanks, chest and belly are pinkish-brown. Dark pigment is present on the proximal half of the membrane of the dorsal, anal, pelvic and pectoral fins. The caudal fin has a uniform mid-brown colouring. The colour notes are based on alcohol-preserved specimens (three of which are comparatively recent), but no difficulty was experienced in separating this species, on colour alone, from *Barbus caudovittatus*. In the latter species the dark pigment is found on the distal half of the pectoral, pelvic and anal fins. The colour pattern is sometimes bleached out in specimens that have been badly preserved or have been preserved for a long time.

DISTRIBUTION. The specimens examined came from Lake Mweru, from between Kolwezi and Jadotville on the Lualaba, Upper Katanga, from Mwena, a tributary of the Lufira, Upper Katanga, from Gombela, Upper Katanga, from Kabiyashi on

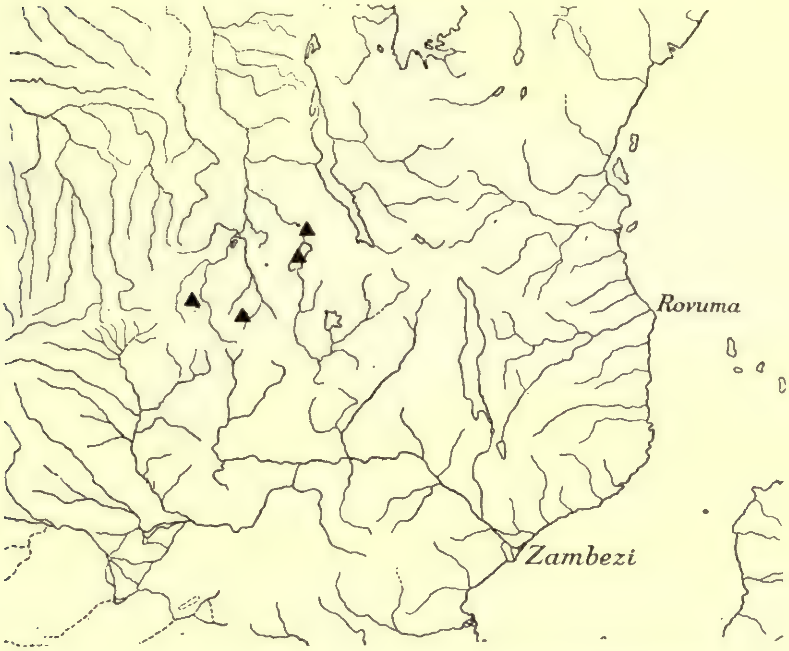

FIG. 101. A map of the distribution of *Barbus trachypterus*.

the Luanza, Upper Katanga, from Ngundeulu, Elizabethville (= Lubumbashi), and Kando, near Tenke, Upper Katanga.

AFFINITIES. The tubercles, the ventral mouth and the crowded pharyngeal teeth are reminiscent of the condition found in many species of the genus *Varicorhinus*. It is interesting to note that Poll (1948) thought that the relationships of *Varicorhinus bredoi* lay with *Varicorhinus stappersii* (here considered to be a synonym of *Barbus caudovittatus*) and *Varicorhinus brucii* (which was considered to be a variant of *Barbus marequensis* by Groenewald 1958). *Barbus trachypterus* specimens have often been confused with *Barbus caudovittatus* specimens but can be distinguished by the presence of a stronger dorsal spine and by a different colour pattern. Both *Barbus trachypterus* and *Barbus caudovittatus* have a ventral, curved mouth and possess a colour pattern unlike many of the east African species. The affinities of *Barbus trachypterus* could well lie with *Barbus caudovittatus* but much more needs to be known about the *Barbus* species of the southern and eastern parts of the Congo before a more informed conclusion can be drawn.

## ***Barbus tropidolepis*** Boulenger 1900

*Barbus tropidolepis* Blgr., 1900, *Annls. Mus. r. Congo Belge Zool.* **1** : 133, pl. xlix ; Poll, 1953, *Result. scient. Explor. hydrobiol. Lac Tanganyika* **3** (5A) : 74.

*Varicorhinus chapini* Nichols & LaMonte, 1950, *Proc. biol. Soc. Wash.* **63** : 175 (*fide* Poll, 1952, *Revue Zool. Bot. afr.* (46) **3–4** : 222).

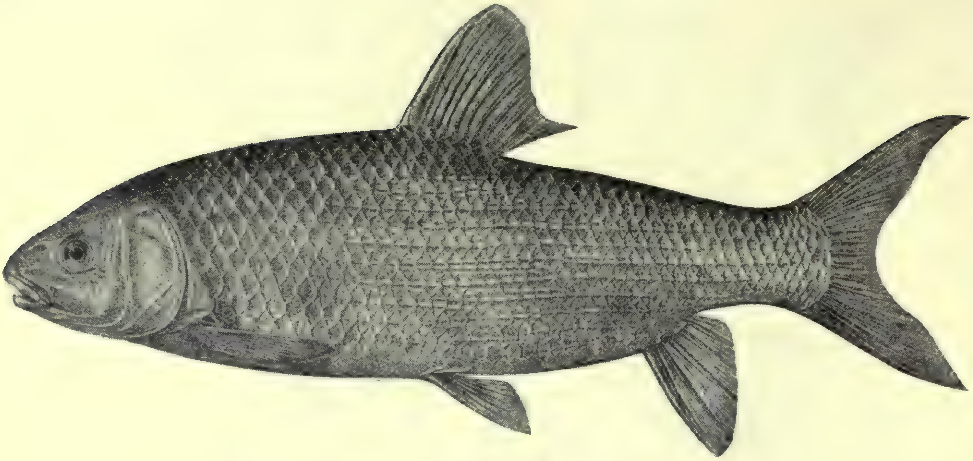

FIG. 102. *Barbus tropidolepis* 'Type' specimen (from Boulenger 1911a).

LECTOTYPE. Boulenger described this species from three fish from Usambura, Lake Tanganyika [B.M. (N.H.) Reg. Nos. 1906.9.6 : 19–21]. The smallest specimen, 239 mm S.L., is recognized as the lectotype.

DESCRIPTION. The description is based on 47 fish of 99 to 365 mm S.L. The morphometric data are expressed in tabular form below.

| | x̄ | s.d. | s.e. | range |
|---|---|---|---|---|
| D | 28·8 | 2·7 | 0·6 | 25·0–33·7 |
| H | 27·0 | 1·4 | 0·3 | 24·8–30·1 |
| I | 9·4 | 1·3 | 0·3 | 7·0–11·0 |
| IO | 9·0 | 1·5 | 0·3 | 7·4–11·4 |
| MW | 6·4 | 0·8 | 0·2 | 5·2– 8·8 |
| Pct | 20·8 | 1·0 | 0·2 | 19·1–23·9 |
| CPl | 14·9 | 1·2 | 0·3 | 12·9–17·7 |
| CPd | 11·7 | 0·9 | 0·2 | 10·1–13·7 |
| Snt | 8·4 | 1·0 | 0·2 | 5·2– 9·3 |

The eye is large and frequently protuberant. The characteristic body shape is shown in fig. 102. Although the anterior barbel is invariably absent and the posterior represented by no more than a small protrusion (as in many African *Varicorhinus* species) the mouth is no wider than in most *Barbus*. Worthington & Ricardo (1937) noted that the degree of lip development varies from continuous to discontinuous. A few specimens have thickened lips but in none of the fish examined were 'rubber lips' or '*Varicorhinus*-like' lips developed. The mouth is ventral under an obtuse snout.

*Squamation.* The lateral line has from 39 to 44 scales : 39 (f.2), 40 (f.9), 41 (f.11), 42 (f.13), 43 (f.9), 44 (f.3). There are 8·5 (rarely 7·5) scales between the dorsal midline and the lateral line and 8·5 (rarely 7·5, very rarely 9·5) between the lateral line

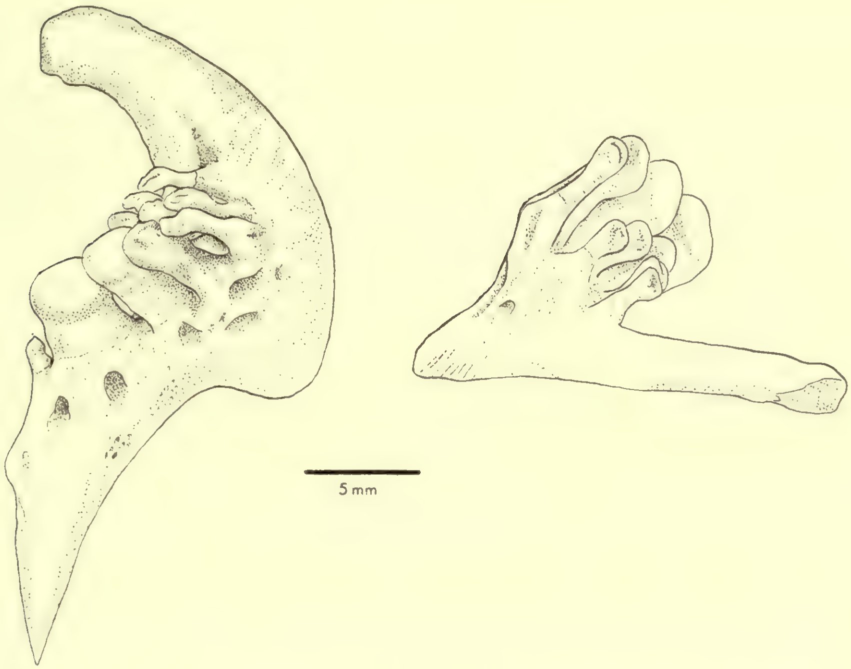

FIG. 103. The dorsal and lateral aspects of the right pharyngeal bone from *Barbus tropidolepis*.

and the ventral mid-line. Five and a half scale rows (rarely 4·5) lie between the lateral line and the pelvic fin base. Around the caudal peduncle are 16 (f.34), 17 (f.6) or 18 (f.7) scales. The most remarkable feature of the scales of *Barbus tropidolepis* is the presence of longitudinal folds of fat which form well-marked ridges on the body. These are most frequently found below the lateral line and from the middle to the posterior of the body. Not all specimens have them, e.g. B.M. (N.H.) Nos. 1936.6.15 : 596–598, fishes of 156 to 200 mm S.L. lack the ridges whilst they are present in other fish of less than 100 mm S.L.

*Dorsal fin.* It has four unbranched rays [not three as reported by Boulenger (1911a) and Worthington & Ricardo (1937)]. The last unbranched ray is ossified to form a smooth stout spine which varies in length from 20·8 to 30 per cent ($\bar{x}$ = 25·8, s.d. = 2·7, s.e. = 0·6). There are nine (rarely 10) branched rays. The dorsal margin of the fin is frequently markedly concave with its posterior corner extended a little (see fig. 102). The dorsal fin origin is in advance of or above the origin of the pelvic fin.

The *anal fin* has three unbranched rays and five branched rays.

*Pharyngeal bones and teeth.* The pharyngeal teeth are molariform (fig. 103). The first tooth in the inner row is very small and in a few cases is absent although a small pinnacle of bone marks its site. The second tooth is large with a slightly

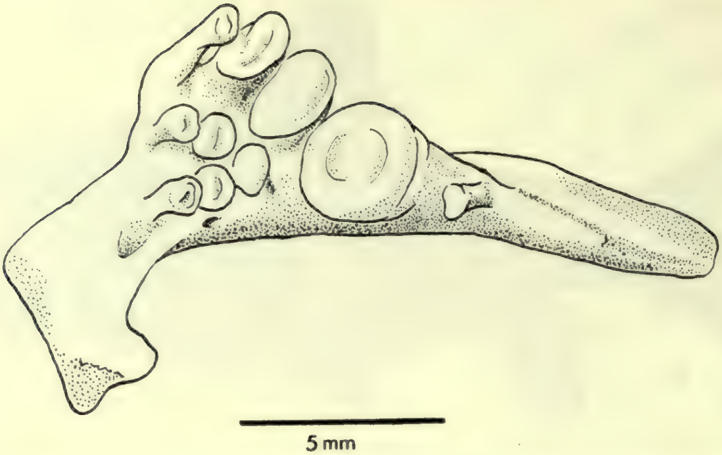

FIG. 104. The pharyngeal bone of *Barbus tropidolepis* positioned to show the alignment of the tooth rows.

concave crown. The third and fourth teeth are wider than they are long with concave posterior faces. The fifth tooth is conical and may be recurved. The alignment of the second and third rows is rather unusual in that the first tooth of the second row is slightly displaced dorsally so that both rows seem to radiate from that tooth. In the other species under consideration the second and third rows are distinct and parallel (*cf.* figs. 103 and 104). The pharyngeal teeth resemble those of *Barbus platyrhinus* (see p. 108).

*Coloration.* Brown or olive-brown above, lighter brown or silvery below in preserved fishes.

DISTRIBUTION. This species is endemic to the Lake Tanganyika basin. Poll (1953) gives a full list of the localities in this region where *Barbus tropidolepis* has been captured.

DIAGNOSIS AND AFFINITIES. *Barbus tropidolepis* appears to occupy a rather isolated position among East African *Barbus*; only *Barbus platyrhinus* has some features in common. The large number of scales, the development of ridges of fat on the scales and the shape of the pharyngeal teeth are indicative of the dissimilarities between this species and those of the neighbouring areas and it is clearly distinct from *Barbus caudovittatus*, the other large *Barbus* species in the lake.

It has certain features, in common with *Varicorhinus tanganicae*, viz. a high number of lateral line scales, a thick dorsal spine, large eyes and a similar snout. The phyletic significance of these similarities is doubtful. The number of pharyngeal teeth is the same but the alignment is different.

On the other hand, the unique specimen of *Varicorhinus chapini* is definitely a small *Barbus tropidolepis* with a slightly unusual mouth. The measurements of this small fish do not differ from equal-sized *Barbus tropidolepis* specimens.

## DISCUSSION

Particularly noteworthy is the remarkable degree of variation in lip form, body shape and dorsal spine strength within some of the species described above (e.g. *Barbus altianalis* and *Barbus intermedius*).

These two species were represented by very large series of specimens (213 and 454 fishes respectively), so whether the same degree of variability would be shown by other species when equally large samples were studied or whether these two species are inherently more variable than the other described species cannot at the moment be determined. *Barbus bynni* (59 specimens) shows much less variation. The same is true of *Barbus oxyrhynchus*, which although more variable in body form than *Barbus bynni* (*cf.* the type of *Barbus labiatus*, fig. 78, with the type of *Barbus hindii*, fig. 79) does not approach the degree of variability shown by *Barbus intermedius*. *Barbus oxyrhynchus* is represented by 108 specimens, i.e. more than *Barbus bynni* and less than *Barbus altianalis* of *Barbus intermedius*. Without large series of specimens this matter cannot be taken further.

The intraspecific variation of the pharyngeal teeth is as large as the interspecific variation (excluding *Barbus tropidolepis* and *Barbus platyrhinus*, both of which have a very large degree of molarization of the pharyngeal teeth). It seems that the molarization of, particularly, the second tooth of the inner row is of no significance in establishing the identity of a specimen. The range in pharyngeal teeth shapes found in *Barbus intermedius* (figs. 56, 57 and 58) and *Barbus altianalis* (figs. 13 and 14) show this well. The seemingly random occurrence of a molariform second tooth in the inner row is shown by the series of pharyngeal bones of two of the subspecies of *Barbus altianalis* (figs. 13 and 14, also p. 20).

It was suggested above (p. 16) that the shape and strength of the pharyngeal bones and teeth might be influenced by the diet. The pharyngeal bones of *Barbus altianalis radcliffii* are stouter than those of *Barbus altianalis eduardianus*. Whether or not this is an effect of dietary differences could be checked comparatively easily by field studies.

It is known that water-snails are much less abundant in Lakes Edward and George than in Lake Victoria, and the differences between the pharyngeal teeth and bones of the populations of the cichlid *Astatoreochromis alluaudi* in these lakes has been associated with this fact. Greenwood (1964) has shown the differences in the stoutness of the pharyngeal teeth and bones to be phenotypic. Comparative data on the diets of the populations of *Barbus altianalis* in these lakes are lacking, but the striking similarity between the two phenomena is suggestive.

The presence of massive pharyngeal bones in large, deep-bodied specimens (p. 16) is possibly directly related to body depth. The '*surkis*' form of *Barbus intermedius* has been shown to have been feeding on gastropod molluscs and the likelihood of the '*obesus*' form of *Barbus altianalis radcliffii* also having gastropods as an important part of its diet has been mentioned above, although no identifiable remains were found in its alimentary tract. As only the deep-bodied examples of populations which consume gastropods display this phenomenon, it is more likely that the length of the pharyngeal bone is associated with the depth of the body as was noted on p. 16.

Wunder (1939) experimented on Common Carp (*Cyprinus carpio* L.) and observed that controlled feeding could produce a 'hunger' form and a 'fattened' form. The former resemble the '*gorguarii*' form of *Barbus intermedius*, with a shallow body and a relatively long head. The fattened form resembled the '*surkis*' form of *Barbus intermedius* (fig. 32) or the '*obesus*' form of *Barbus altianalis* (fig. 3) in having a deep body, a relatively short head and stubby fins.

It is not possible to say whether greater body depth in a fish induces longer (but presumably not necessarily stouter) pharyngeal bones or whether extra food produces a deep-bodied fish in which the pharyngeal bone size relates to the kind and amount of food rather than to body depth. It has not yet been possible to determine the effect that a deeper body has on the depth of the head. It would be interesting to know if the '*gorguarii*' and '*surkis*' forms of *Barbus intermedius* represent poorly fed and well-fed populations. This could possibly be answered by field studies, but until that time one can do little but accept the various forms as different phenotypes or eco-phenotypes of variable species. It is important to note that the deep-bodied forms have so far only been found in lakes whilst most of the other body and lip forms occur throughout the range of the species. There is, regrettably, insufficient information available to comment further on the variation of these *Barbus* species.

As in the small *Barbus* with radiately striated scales described by Greenwood (1962), supra-specific complexes are discernible in the large *Barbus* described above. These complexes (see below) are difficult to define precisely since they are based on the rather amorphous (although useful) concept of general appearance. It must also be borne in mind that the species described here represent only a fraction of the total number of species of the large African *Barbus*. The extent and composition of the supra-specific assemblages will doubtless have to be re-evaluated when the phyletic interrelationships of the African *Barbus* are better understood.

Two complexes can be recognized amongst the species studied :

1) The *Barbus intermedius* complex. This comprises *Barbus intermedius*, *Barbus altianalis*, *Barbus acuticeps* and *Barbus ruasae* which inhabit most of the rivers of southern and eastern Ethiopia and northern Kenya, the Blue Nile system (including Lakes Rudolf and Baringo), the Lake Victoria basin and the lakes in the adjacent parts of the western rift valley. The lateral line scale counts range from 25 to 36 but are most frequently 28 to 32. Typically, the body is shallow, the caudal peduncle substantially longer than deep and the dorsal spine is smooth, strongly ossified and shorter than in the *Barbus bynni* complex (see below). The scales possess many parallel or slightly converging striae. At least two of the component species (*Barbus intermedius* and *Barbus altianalis*) are noteworthy for their high phenotypic variability. The species in this group show strong gross morphological resemblances to the *Barbus* of western and southern Saudi Arabia (e.g. *Barbus arabicus* Trewavas, 1939 and some as yet undescribed species from Aden) as well as to species like *Barbus batesii* Blgr. 1903 from South Cameroons. The significance of their distribution will be discussed below.

2) The *Barbus bynni* complex. This group contains *Barbus bynni*, *Barbus gananensis*, *Barbus oxyrhynchus* and *Barbus longifilis* which inhabit the White and Albertine Niles, lakes at the fringe of the Blue Nile system (Abaya and Rudolf),

the eastern part of the Juba river, the Athi and Tana rivers and the Loama and Kanséhété rivers (upper Congo to the west of Lake Kivu). The lateral line scale count range is from 21 to 37, the most southerly species (*Barbus oxyrhynchus*) having a lower range than the rest, modally 24–25 against 31–33. The trend towards larger scales in southerly forms has been noted before by Greenwood (1962) for *Barbus paludinosus* and *Barbus kerstenii*. The scales have fewer striae than in the *Barbus intermedius* complex and the striae are more sinuous The caudal peduncle is deeper in relation to its length than in the *Barbus intermedius* group and the dorsal spine is noticeably long and straight (p. 28). *Barbus oxyrhynchus* has one or two more branched rays in the dorsal fin than the other species in this group. *Barbus mariae* of the Athi river which is sympatric with *Barbus oxyrhynchus* does not seem to have much in common with the *bynni* complex, except a long dorsal spine and a similar lateral line scale count range.

One feature, the presence of small scales, is common to several lacustrine species : *Barbus tropidolepis*, *Barbus ethiopicus*, *Barbus platyrhinus* and *Barbus microterolepis* (see below). It is not suggested that these species are related, merely that the character has been acquired independently by the species that live in, and probably evolved in, lakes. Small-scaled, large *Barbus* species are not necessarily lacustrine though, as some of the fluviatile South African species (e.g. *Barbus polylepis*) show. It is possible that the modally higher lateral line scale count in *Barbus altianalis* amongst the *Barbus intermedius* complex is connected with its confinement in lake basins. However, its confinement in lake basins is not the same as the confinement in lakes of *Barbus tropidolepis* etc. There are populations of *Barbus altianalis radcliffii* which appear to be permanent inhabitants of the Kagera river (Dr P. H. Greenwood, pers. comm.). Superficially these fishes do not appear to differ from those in Lake Victoria, but no detailed investigations have been carried out. The lacustrine *Barbus altianalis radcliffii* do not spend all their time in the lake, they display their fluviatile ancestry by ascending rivers to breed (Whitehead 1959).

*Barbus tropidolepis*, it should be noted, also ascends rivers to breed (Poll 1953) but does not apparently live in rivers outside of the breeding season. Nothing is known about the habits of *Barbus ethiopicus*, *Barbus platyrhinus*, nor *Barbus microterolepis*.

In this context there are some ideas of Farquharson (1962) that must be considered. He discussed the distribution in South Africa of the small-scaled *Barbus* species (e.g. *Barbus natalensis*, *Barbus holubi*, *Barbus capensis* and *Barbus kimberleyensis*) with parallel scale striations. From their widespread distribution and endemism he suggested that an ancient dispersion is indicated. If this is so, then it is possible that the small-scaled lacustrine species mentioned above are relicts of this dispersion southwards (see above). I have not been able to compare specimens of the small-scaled South African species with the small-scaled species from Lakes Tanganyika and Zwai.

Farquharson (*ibid.* : 247) discusses the influence of water temperature on scale number and lists a series of *Barbus* species arranged in order of localities from 'hot' to 'cold' showing the increase in the number of lateral line scales. Regrettably, the situation is not as simple as this as, for example, the review by Tåning (1952) shows. There may be some basic truth in Farquharson's idea but at the moment there is insufficient data to put forward a general case.

It is suggested here that *Barbus altianalis* came from the same stock as *Barbus intermedius* and that the smaller scales developed after it was confined to the lake basins, subsequent to the rift valley formation (see p. 22). *Barbus microterolepis* could also have been derived from *Barbus intermedius* in this fashion (assuming that it is a good species and not a hybrid or genetical abnormality – see p. 91).

No other supra-specific groups are recognizable among the species described. The affinities of *Barbus stappersii* would seem to be with the Zambezi species *Barbus marequensis*. *Barbus caudovittatus* is probably associated with Congo species and hence outside the scope of this paper. Too few specimens of some of the other species are available to be able to evaluate their characters, but a revision of the Congo *Barbus* may give some indications of their relationships.

The problematical relationships of *Barbus macrolepis* may not be solved until the *Barbus* species of West Africa are revised. The remarkable similarity of this species to *Barbus lagensis* from Nigeria is noted above (p. 83).

*Barbus somereni* and *Barbus mirabilis* do not seem to be related to any of the other species described in this paper. Again, a study of the Congo fauna may reveal species related to these two.

It is, perhaps, interesting to compare the distribution of the small *Barbus* species with radiately striated scales with that of the large *Barbus* species described above. The small *Barbus* species are widely distributed and several species are found in widely separated river systems. By contrast the most widespread of the large *Barbus* species described in this paper are found in palaeogeographically closely related and/or adjacent river systems. Presumably the small *Barbus* species are able to travel from one river system to another via the swamps which frequently form the watersheds. Bell-Cross (1965) noted that the only *Barbus* species living in the watershed on the Muhinga plain which separates the Congo from the Zambezi system are small, 'radiately striated' species. The large *Barbus* species would seem to be less successful at negotiating the small streams, seasonal ponds and swamps at the headwaters of the river systems. Their larger size must be a contributing factor, certainly none have been found at the extremities of river systems. Bell-Cross (1960) suggested that the reason why some fishes did not cross watersheds was not necessarily because of their physical inability to do so but because of some other factor like behavioural inhibitions. Regrettably there have been very few observations on this problem. Darlington (1957 : 78–80), however, argues that given enough time primary fresh-water fishes (e.g. Ostariophysi) can overcome almost any physical barriers limiting their range. Perhaps the time scale involved is not large enough to be applicable to the large *Barbus* species in this context.

If the habitats of the large *Barbus* species are likely to be isolated, the possibility exists that the relationships of various species might prove useful as indicators of the relationship of river systems and vice versa.

If the rate of phenotypic change is less than the time taken for rivers to be dissociated then it is feasible to think that the now-separated populations of fishes would be detectable as members of the same taxon. The general principle of this idea is borne out in certain instances, e.g. between *Barbus altianalis* and *Barbus intermedius,* between *Barbus somereni* and *Barbus mirabilis* and between the members of the *Barbus bynni* complex. The geographical evidence for this idea in the *Barbus bynni* complex is lacking in detail, but there is nothing geographically inconsistent in the former association of their river systems (see p. 22).

Günther (1869), writing on the Nile fishes collected by Petherick, noted that the upper Nile fauna is related more closely to that of the Palestinian and West African rivers than to the fauna of Lake Nyasa (Malawi) and the Zambezi river. By 1880 Günther had expanded the horizons of the affinities of the African fresh-water fish fauna. He thought that as some families had more representatives in India than in Africa they probably originated in India or derived from an Indian stock. He also considered the fauna of Jordan and Syria to have so many African representatives that he included them in the African region as well as in his Euro-Asiatic region.

Gregory (1896) reviewed the evidence for the faunal similarities between the Nile and Jordan rivers and concluded that the Jordan river has species in common with the upper, but not with the lower Nile. Because of this, he conjectured that in the past a river flowed from Lakes Albert and Victoria, which then had no outlet to the Nile, into Lake Rudolf and then via the Omo and Hawash rivers across the Afar depression into the Red Sea. The Red Sea trough would, he thought, at that time have been filled with fresh water and with an extension of the Jordan river flowing into it.

Nichols & Griscom (1917), with a great many more species at their disposal than were available to Gregory, divided the fish fauna of Africa into six regions and commented on the relationships of one faunal area to another. It is probably significant that the boundary line between their 'Nile and North East Africa' region and their 'East African' region follows closely the boundary between the ranges of *Barbus intermedius* and *Barbus oxyrhynchus.* The fish of North West Africa, they noted, have affinities with the European fishes. The fauna of the 'Nile and North East Africa' region had affinities both with the West tropical Africa region (Nichols and Griscom postulate extensive contact in the past between the Nile and the Congo) and northern or Asiatic forms. The fauna (particularly the Cyprinidae) of the Nile and North East Africa region '. . . seem invariably to have entered Africa from the north-east. They predominate in the Nile basin and East Africa, reaching South Africa but are much more poorly represented in West Africa.'

Menon (1964) in his revision of the cyprinid genus *Garra* decided that the African *Garra* species came into Africa in a series of waves, each succeeding wave dispersing the forms that came in the preceding wave. His postulated routes for this were either via the Sinai peninsula or via Saudi Arabia and Somaliland before these two countries were separated by the Red Sea. The evidence for this is somewhat sparse, the idea being based on the general pattern of the distribution of cyprinids in Asia and the pattern of distribution of fishes in Africa with the most archaic forms in the west (Darlington 1957 : 60).

There exist in south-western Saudi Arabia and Aden some *Barbus* species (*Barbus arabicus* Trewavas 1939 – and some undescribed species) which would fit in well with the *Barbus intermedius* supra-specific complex. The question that cannot yet be answered is whether the Arabian species represent relict populations of the migration of the *Barbus intermedius* ancestral stock into Africa or whether they represent a radiation from Ethiopia into Arabia. In either case the increase in the salinity of the Red Sea (possibly during the Pliocene – see below) severed contact between the two groups.

The geological history of the Red Sea is not known in great detail, but enough is known to enable a brief history to be constructed. Dubetret (1970) considers the Red Sea cut across the Precambrian rocks forming the African and Arabian shield. Up to the Miocene it seems that marine incursions along the incipient Red Sea trench were confined to the northern end (north of Quasir 27°5′ N) where upper Cretaceous marine deposits are found. The Neogene history is better known.

Dubetret (*op. cit.*) dates the Red Sea from the Miocene. Foundering from the Lower Miocene resulted in the Mediterranean Sea flowing into the Gulf of Suez to approximately the southern end of the Red Sea. A land barrier existed at the south separating the Mediterranean water from the Indian Ocean water. During the late Miocene and Pliocene an upward earth movement in the Gulf of Suez area cut off the Red Sea from the Mediterranean.

In the Pliocene the southern land barrier sank and allowed Indian Ocean water to flow into the inland sea. The northern land barrier prevented any contact with the Mediterranean.

Botros (1971) thinks that a series of fresh-water lakes was present in the southern part of the Red Sea trench during the Oligocene and late Eocene, whilst the northern end was an arm of the Mediterranean Sea. He is also of the opinion that it was possible for the land bridge across the southern end of the Red Sea to have become apparent again during the Pleistocene as a result of the lowering of the sea level during the Ice Ages.

It seems then that what is now Arabia (Roberts 1970 : fig. 2) did not separate from the horn of Africa until the end of the Miocene or early Pliocene and that the two land masses may have been in contact again during the Pleistocene. It can therefore be surmised that there was enough contact over a long period of time for Asiatic cyprinids to have migrated into Africa or vice versa.

The pattern of distribution of the supra-specific complexes defined above (fig. 105) refines the problem but does not solve it. The geographically most compact supra-specific complex (the *Barbus intermedius* complex) is in northeast Africa (and it is suggested, in Saudi Arabia). This is ringed to the west and south by the rather more fragmented and scattered members of the *Barbus bynni* supra-specific complex. Still more scattered are the localities for *Barbus somereni* and *Barbus mirabilis*. This distribution could be interpreted as the result of a series of invasions from the northeast. *Barbus lagensis* and *Barbus macrolepis*, if they are as closely related as the available evidence suggests, could represent the remnants of an early scattering of species caused by these invasions (see p. 83).

The reasons for this apparent effect are unknown, but it could be related to the formation of topographical changes in the Ethiopian highlands. The tectonic movements must have had a profound effect in altering the courses of rivers, linking some and separating others. This could have happened more than once and over a

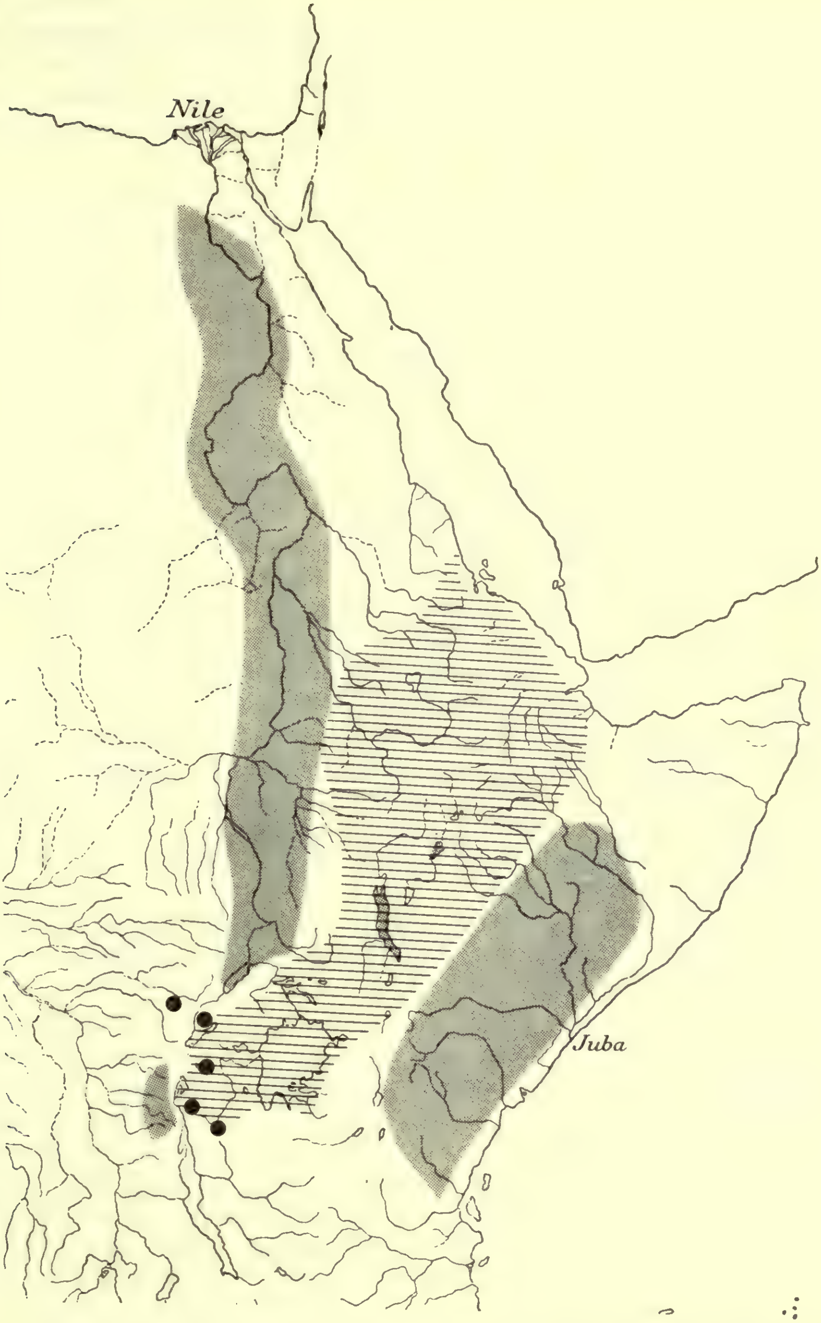

Fig. 105. A map of the distribution of A) the *Barbus intermedius* supraspecific complex (hatched area), B) the *B. bynni* supraspecific complex (dark area), C) *B. somereni* and *B. mirabilis* (solid circles).

long period of time, which could ultimately cause speciation within a previously uniform population. Unfortunately the geological history of this region is poorly known. Migration west and south would scatter the daughter species. Any subsequent waves of immigration in this region might hence be subject to the same kinds of isolation as the earlier waves and further supra-specific complexes would result.

There is evidence to suggest that fishes have been able to move from northeast Africa into the middle east. The presence of *Tilapia* species in Jordan is an example of this. The only conclusions that can be drawn about the large *Barbus* species is that they were at some stage able to move between the horn of Africa and Saudi Arabia. It would need fossil evidence to show in which direction the movement took place. Brown (1970) reports the presence of *Barbus* species and *Tilapia* species in the late Oligocene or Miocene of Jizan (Saudi Arabia, just north of the Yemen border).

The large *Barbus* species of Africa are, as a group, quite distinct from the majority of species living in the Tigris and Euphrates rivers (the nearest region with a good cyprinid fauna). The Tigris and Euphrates species mostly resemble *Barbus barbus* L. of Europe in possessing relatively small scales and a serrated dorsal spine. Of the smooth dorsal spined species from Syria, *Barbus canis* C. & V. (*Tor canis* of Karaman 1971) most closely resembles the African species, especially the *Barbus intermedius* complex. An isolated population of *Barbus canis* from Khamis Mushyat (18°17′ N, 42°34′ E – about 400 km southeast of Jeddah, Saudi Arabia) is the population closest to the African continent. The members of this population are less like the African *Barbus* species than are the Syrian populations as they lack the anterior pair of barbels. The fish fauna of Saudi Arabia is sparse and too poorly collected for opinions to be formed on whether the absence of the anterior barbels in the Khamish Mushyat population is a local phenomenon or part of a clinal phenomenon. The *Barbus* species of Aden are, as has been mentioned above, extremely similar to *Barbus intermedius*.

The presence of *Barbus* species in Saudi Arabia which closely resemble some of the African species presents two possibilities about the origin of the African representatives.

Firstly, did the *Barbus* species now typical of Africa evolve in Africa from dissimilar ancestors of which now no trace remains? If so, then the Arabian and Syrian smooth-spined *Barbus* species could represent the relicts of a migration from Africa. The centre of this particular radiation could well have been in Ethiopia as the African and Arabian land masses must have been in contact. Therefore the status of the Arabian and Syrian species would be the same as *Barbus altianalis* and *Barbus ruandae*, i.e. the members of the *Barbus intermedius* supra-specific complex.

The other possibility is that the facies characteristic of the African *Barbus* species were to some extent present in the ancestral stock. If this were so, and if the ancestral stock was not originally African, could the Arabian and Syrian species of the *Barbus canis* type represent remnants of the ancestral stock?

Not enough is known at the moment to be able to decide which of these two possibilities (if either) represents the truth and it is quite possible that the notion of a series of migrations all in the same direction is far too simple. The ideas in the previous two paragraphs refer only to the putative last migration that produced the species forming the *Barbus intermedius* supra-specific complex. Of the even earlier migrations and scatterings conjectured from the distribution of the extant species there is no trace, but this does not affect the equally likely (on available evidence) alternative ideas on the relationship of the *Barbus intermedius* complex to the relevant *Barbus* species of Saudi Arabia and Syria.

However, no firm conclusions can be drawn until the fossil record and the phylogeny of this group of *Barbus* species are better known. For a full understanding of the phylogeny and distribution of the African *Barbus* species, the relationship of the small 'radiately striated' *Barbus* species to the large *Barbus* species must be determined as well as the relationships of the African *Barbus* species *sensu lato* to the *Barbus* species of Europe and the Near East. The distributional problems relate principally to the role of the closely related cyprinid genera, i.e. why should there be a relative paucity of large *Barbus* species in west Africa but a comparative abundance of *Varicorhinus* species and *Labeo* species? The reverse situation exists in the east. In all probability the solutions to these problems lie as much in the sphere of the field worker as in the sphere of the museum worker.

## ACKNOWLEDGEMENTS

Many people have helped me in the production of this paper and it is with considerable pleasure that I take this opportunity of thanking them all.

My senior colleagues Dr P. H. Greenwood and Dr E. Trewavas have spent many hours discussing speciation and zoogeography and have generously given me the benefit of their knowledge and experience of African fish. Dr M. Poll of the Central African Museum, Tervuren, Belgium, gave me facilities to study the collections in his charge as well as readily sending specimens. Dr W. Klausewitz of the Senckenberg Museum, Frankfurt, Dr E. Tortonese of Genoa, Dr C. Karrer of Berlin and Dr J. C. Tyler of Philadelphia respectively allowed me to examine the collections of Rüppell, Vinciguerra, Pappenheim and Donaldson-Smith. Through the good offices of Dr Letitzia Ferrara of the Stazione Idrobiologia, Rome, I was able to examine Dr G. Bini's extensive collections from Ethiopia.

I want to express my gratitude to Miss M. A. McLellan for the help she gave me in preparing the graphs and with the calculations. The drawings of the pharyngeal bones are the work of Mr G. J. Howes and the uncredited drawings of whole fish are the work of Mrs S. Chambers. Mr J. Chambers prepared some alizarin specimens.

Dr W. W. Bishop has helped considerably in advising me and giving me information on stratigraphical and palaeogeographical matters. The staff of the Royal Geographical Society deserve my heartiest thanks in tracing localities that I had thought were untraceable.

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## APPENDIX 1

### An artificial key to the *Barbus* species described in this paper

1. Ll : > 46
Lake Zwai basin . . . . . . . . *B. ethiopicus*

2. Ll : 38–44
a) No anterior barbel ; posterior barbel minute ; ridges of fat on scales of adults
L. Tanganyika basin . . . . . . . *B. tropidolepis*
b) Anterior barbel present
i) IO more than 8 per cent S.L. ; heavy-bodied, bulky appearance ; pharyngeal bones short and thick, pharyngeal teeth molariform
L. Tanganyika basin . . . . . . . *B. platyrhinus*
ii) IO less than 8 per cent S.L. ; compressed, slender body ; pharyngeal teeth thin and hooked
L. Zwai basin . . . . . . . . *B. microterolepis*

3. Ll : < 38
a) Last unbranched dorsal fin ray weak and flexible with persistent articulations
i) CPl > CPd ; body shallow ; L24–30 (most often 26–28), striae on scales parallel
L. Tanganyika basin and upper reaches of Congo . *B. caudovittatus*
ii) CPl ≏ CPd ; body deep ; scales with few converging striae (fig. 64)
Lower Malagarasi and Tanzanian coastal rivers . *B. macrolepis*
b) Last unbranched dorsal fin ray ossified without articulations, at least in basal half
i) Body typically deep ; CPl ≏ CPd
† Dorsal spine thin, only ossified basally
L. Mweru region . . . . . . . . . *B. stappersii*
†† Dorsal spine long, thick and strong . . . *B. bynni* complex
(except in *B. pagenstecheri*) (see below)
ii) Body typically shallow ; CPl > CPd
† Dorsal spine massive, long ; upper jaw curves down to cover the lower jaw laterally giving a 'clupeoid' appearance to the mouth ††
Athi–Tana system . . . . . . . . . *B. mariae*
†† Dorsal spine not as above
‡ mouth ventral ‡‡
☐ straight edge to square LJ ; very small barbels ☐☐
Rwanda . . . . . . . . . . *B. microbarbis*

□□ mouth semicircular
* Dark pigment of distal portions of pectoral, pelvic and anal fins
Upper Congo, W. of L. Kivu . . . . . *B. paucisquamatus*
** Dark pigment on proximal parts of pectoral, pelvic and anal fins
L. Mweru region . . . . . . . . *B. trachypterus*
‡‡ mouth not as above
■ striae on scales vary with position of scale on body, typically striae more radiate on belly than on back; DIV-9 or 10 ■■
○ Bulky body (fig. 74)
West of rift valley . . . . . . . *B. mirabilis*
○○ Body not bulky
Ruwenzori mountains and upper Malagarasi . . *B. somereni*
■■ striae ± parallel and sinuous, no great variation in pattern with position on body; DIV-8 or 9
*B. intermedius* complex (see below)

## *Barbus bynni* complex

1) DSP, $\bar{x}$ = 30·0, spine strong . . . . . . . . . . 2)
Nile, L. Albert, L. Abaya, L. Rudolf . . . . . *B. bynni*
2) DSp, $\bar{x}$ = 25·0–30·0, strong . . . . . . . . . . . . . 3)
a) Ab, $\bar{x}$ = 9 (range 8–10); Pb, $\bar{x}$ = 11 (range 9–12). Pct 21–24
Congo W. of L. Kivu . . . . . . . *B. longifilis*
b) Ab, $\bar{x}$ = 6 (range 3–10); Pb $\bar{x}$ = 7 (range 3–12). Pct 22–28, $\bar{x}$ = 24·4
Athi and Tana systems . . . . . . *B. oxyrhynchus*
3) DSp 25·0 or less, but weaker than above
Juba river . . . . . . . . *B. gananensis*
4) DSp 20·0 or less, shallow body
Kilimanjaro region . . . . . . . *B. pagenstecheri*

## *Barbus intermedius* complex

1) Dorsal profile of head concave; mouth opens antero-dorsally; nuchal hump present
Ll 27–30; DSp, $\bar{x}$ = 22·3
Rwanda and Burundi . . . . . . . . *B. acuticeps*
2) Dorsal profile of head not concave, mouth sub-terminal or terminal
i) Ll 25–26; pharyngeal teeth tend to be molariform
Rwanda . . . . . . . . . . . . *B. ruasae*
ii) Ll 28–35 (most often 30–34, m = 32)
DSp, $\bar{x}$ = 16·9; Ab, $\bar{x}$ = 4·3; Pb, $\bar{x}$ = 5·4
Lakes Victoria, Kivu, Edward and George . . . *B. altianalis*
iii) Ll 26–34 (most often 28–32, m = 29)
DSp, $\bar{x}$ = 20·1; Ab, $\bar{x}$ = 5·8; Pb, $\bar{x}$ = 6·9
Blue Nile, Ethiopia, Lakes Rudolf and Baringo, western part of Juba . . . . . . . . . . *B. intermedius*

## APPENDIX 2

## Gazetteer

As I have found it very difficult (and in some cases impossible) to find some of the localities mentioned by authors I have compiled this gazetteer giving as many details as I can find of the collecting sites. Grid references are given where possible. The details of the rivers in Ethiopia come entirely from Zaphiro's notebook. Different cultures occupying an area have sometimes changed the names of lakes or rivers. Where possible all the variants are given.

*Abaya* = Abbaya, the northern lake of a pair of lakes. The name has been loosely applied to either or both lakes in the southern part of the Ethiopian rift valley. G.R. 6°30′ N 30°00′ E. (See Chiamo, Ganjule, Margharita, Ruspoli.)

*Akaki*, a river, 10–12 m wide, due south of Addis Ababa, it runs from Legadi south to the Hawash.

*Alaba*, a river, some 20 m wide, runs from the Kambata plains to Lake Ganjule. Collecting altitude 6000 feet.

*Arba minch*, tributary of Lake Ganjule.

*Avakubi*, Ituri system (Zaire). G.R. 1°24′ N, 27°40′ E.

*Awata*, a tributary of the Juba river. G.R. 6°05′ N, 39°20′ E.

*Barja*, a river, 10 m wide, collecting altitude 4250 feet. It runs from the hills of Sangana and Bako to the Zuja river (Lake Stephanie basin).

*Basso Ebor*, an old name for Lake Stephanie.

*Basso Narok*, an old name for Lake Rudolf.

*Bis(s)an Guarrica*, a tributary of the Sagan river to the south of Lake Abaya.

*Bobandana*, Lake Kivu basin. G.R. 1°38′ S, 29°00′ E.

*Bushiame* river, Sankuru system. G.R. 6°00′ S, 24°50′ E to 8°00′ S, 23°00′ E.

*Burka*, an affluent of Lake Ganjule.

*Chiamo* (= Ciamo), Lake Ganjule.

*Chirangobo*, an affluent of Lake Kivu.

*Didessa*, a river, some 60 m wide, that runs from Guma to the Blue Nile.

*Elgo*, a fast-flowing river, 15 m wide, collecting altitude 3000 feet, it flows from the Gamu hills eastwards to Lake Abaya.

*Ergino*, a river, 20 m wide, collecting altitude 3000 feet, flows from the Basketo hills northwards to the Omo.

*Errer*, a river in the Webi Shebeli system. G.R. 9°00′ N, 42°20′ E.

*G. el Narua*, Guasso el Narua. G.R. 0°16′ N, 36°18′ E.

*G. Nyuki*, Guasso Nyuki, mouth at 0°28′ N, 36°08′ E (probably a swampy locality).

*Ganda*, a river, 15 m wide, collecting altitude 3000 feet, flows from the hills of Gama to Lake Ganjule.

*Ganjule*, the southern lake of the pair of which the northern lake is Abaya (also called Chiamo, Ruspoli). G.R. 6°50′ N, 37°40′ E.

*Gato*, a fast flowing river, 15 m wide, which rises in the hills of Gandulla and flows west to the Sagan. Collecting altitude 3700 feet. (Lake Stephanie basin.)

*Gibe*, a fast-flowing stream, 20 m wide, which flows directly south from the plains of Gorombi (altitude 2800 feet) (supposed to be the source of the Omo).

*Gofa*, a river, Hawash system.

*Gombela*. G.R. 10°50′ S, 27°50′ E.

*Gudar* (= Gudr), a stream flowing north from the Roggle mountains to the Blue Nile. Collecting altitude 3400 feet.

*Hawash*, most collections in this river were made by Zaphiro at Zeluka, altitude 4100 feet.

*Jerrer*, exact locality untraceable. Mount Jerrer is 32 km southwest of Addis Ababa, according to Zaphiro's notebook, the river is therefore apparently in the Webi Shebeli system.

*Juju*, a river, 10 m wide, flowing from the Guma hills to the Blue Nile. Collecting altitude 2000 feet.

*Kabiashyia*, on the Luanza river, an affluent to the northern edge of Lake Mweru.

*Kando*, near Tenke. G.R. 10°25′ S, 26°10′ E.

*Kanséhété*, a river, an affluent of the Luhoho Congo, due west of Lake Kivu.

*Kassam*, a river, Hawash system. G.R. 9°05′ N, 39°35′ E.

*Kibonoto* (= Kibongoto), an affluent of the Sanya river, Pangani system. G.R. 3°11′ S, 37°06′ E.

*Kibwesi*, a river in the Athi system. G.R. ± 2°25′ S, 37°56′ E.

*Kiyimbi*, a river, Loama–Lualaba Congo. G.R. 5°00′ S, 28°59′ E.

*Koki*, a river, an affluent of Lake Tanganyika. G.R. 6°03′ S, 29°05′ E.

*Laikipa* (Leikipa), an escarpment. G.R. 0°25′ N, 36°10′ E.

*Loama*, an affluent of the Luhoho Congo, due west of Lake Kivu.

*Luembe*, a river = Cashimo river. G.R. 8°00′ S, 21°35′ E.

*Lufiro*, a river. G.R. 2°40′ S, 29°00′ E.

*Luilu*, a river, Sankuru system. G.R. 7°30′ S, 23°30′ E.

*Lusine*, a river, Rwanda, flows from Lake Mohashi into the Akangaru. G.R. 2°30′ S to 6°00′ S, 30°45′ E.

*Mahembe*, on the Nyawarongo river, Kagera system, Lake Victoria basin. G.R. ± 1°52′ S, 29°54′ E.

*Maki*, a fast-flowing stream that originates in the hills of Goraza and flows into Lake Zwai.

*Makindu*, a river. G.R. 2°09′ S, 37°35′ E.

*Malawa*, a river, Lake Victoria basin. G.R. 0°40′ N, 35°30′ E.

*Margharita*, lake = Lake Abaya.

*Metti*, a fast-flowing river, 20 m wide, altitude 3500 feet. Flows from Tuludimtu northwards to the Gudar river. (Blue Nile.)

*Mkunga* (= Mukungwa), a river, near Ruasa, northwest Rwanda, runs from the southeastern part of Lake Luhondo to the Nyawarongo. G.R. 1°35′ S, 29°40′ E.

*Modjo*, a river, Webi Shebeli system.

*Mogre*, a river, tributary of the Blue Nile.

*Mutamphu*, a river, a tributary of the River Akangaru, Kagera system. Specimens with this locality were collected about 12 km along the road to Shangugu from Butare. G.R. ± 2°43′ S, 29°43′ E.

*Mwogo*, an affluent of the Kagera.

*Narok*, a river. G.R. 0°32′ N, 36°52′ E.

*Nyabarongo*, a river in the Luhoho Congo system.

*Nyabugogo*, an affluent of the Lusine river.

*Nyawarongo*, Kagera system.

*Nyundeulu*. G.R. 10°58′ S, 25°50′ E.

*Rugwero*. Lake, Rwanda. G.R. 2°25′ S, 30°20′ E.

*Ruspoli* = Lake Ganjule.

*Sagan*, a fast-flowing stream, 15 m wide, at Wondo (altitude 2800 feet) where most collecting was done. Blue Nile system.

*Sangé*, an affluent of the Ruzizi. G.R. 3°04′ S, 29°08′ E.

*Siré* (= Siri), a stream flowing from the Gamu hills eastwards to Lake Abaya, collecting altitude 3000 feet.

*Suksuki*, a river linking Lake Zwai and Lake Suksuki.

*Tchitatu*, a river, near Luachimo, Upper Kasai region. G.R. 7°40′ S, 20°50′ E.

*Tokwe*, a river, near Bwambe, Uganda.

*Tsavo*, a river. G.R. 2°59′ S, 38°02′ E.

*Tshikapa*, a river, Upper Kasai (Congo) system. G.R. 6°28′ S, 20°48′ E.

*Uaso narok*, a river flowing from the Laikipa escarpment northeastwards to the Uaso Nyiro.

*Urgessa*, a river, 15 m wide, flowing northwest to the Wama river (Blue Nile system).

*Wondinak*, a small stream flowing northwest into the Gibe river (Omo system).

*Zeissi*, a turbulent stream, about 10 m wide, flowing from the Zeissi hills eastwards to Lake Ganjule. G.R. 1°52′ N, 37°29′ E.

*Zendo*, a river, 15 m wide, flowing from the Anko hill eastwards to the Maze river, an affluent of the Omo. Collecting altitude 4300 feet.

*Zuga*, a river, 30 m wide, running from the hill Marta to Lake Stephanie. Collecting altitude 4200 feet.

## APPENDIX 3

*Barbus susanae*, a replacement name for *Barbus gregorii* Norman.

*Barbus gregorii* Norman (1923) from China is preoccupied by *Barbus gregorii* Boulenger (1902) from Africa. Fowler (1958) noticed this and proposed *Barbus yunnanensis* to replace *Barbus gregorii* Norman. Fowler had unfortunately overlooked the fact that *Barbus yunnanensis* had already been used by Regan (1904) for a fish from Yunnan, China, the same area as that from which *Barbus gregorii* Norman comes.

I have examined the type of *Barbus yunnanensis* Regan B.M. (N.H.) Reg. No. 1904.1.26 : 78 and the syntypes of *Barbus gregorii* Norman B.M. (N.H.) Reg. Nos. 1923.2.21 : 29–36, and they are very distinct.

I therefore propose *Barbus susanae* to replace *Barbus gregorii* Norman.

Derivation of name : named after my wife.

Boulenger, G. A., 1902
Description of new fishes from the collection made by Mr E. Degen in Abyssinia. *Ann. Mag. nat. Hist.* (7) **10** : 422.

Regan, C. T., 1904
A collection of fishes made by Mr J. Graham at Yunan Fu. *Ann. Mag. nat. Hist.* (7) 13 : 191.

Norman, J. R., 1923
Three new fishes from Yunan collected by Professor J. W. Gregory, F.R.S. *Ann. Mag. nat. Hist.* (9) **2** : 562.

Fowler, H. W., 1958
Some new taxonomic names for fish-like vertebrates. *Not. nat.* (310). August 1958 : 12.

## APPENDIX 4

A complete list of the registered material examined.

In some cases more specimens were examined than were used in the description of the species, consequently a complete list was deemed advisable.

The Ethiopian *Barbus* spp. from the Stazione Idrobiologia, Rome, do not have any register numbers.

The species are arranged alphabetically and the following code applies :

| | |
|---|---|
| B.M. (N.H.) | British Museum (Natural History) |
| C.F.M. | Chicago Field Museum |
| M.A.C.T. | Musée d'Afrique Centrale, Tervuren |
| M.H.N.P. | Museum National d'Histoire Naturelle, Paris |
| M.S.N.G. | Museo Civico di Storia Naturale G. Doria, Genova |
| P.A.S. | Philadelphia Academy of Natural Sciences, U.S.A. |
| S.M.F. | Senckenberg Museum, Frankfurt |
| S.M.N.H. | Stockholm Museum of Natural History |
| Z.M.B. | Zoologisches Museum an der Humboldt – Universität zu Berlin |
| Z.M.H. | Zoologisches Staatsinstitut und Zoologisches Museum, Hamburg. |

The first paragraph contains the register numbers of the type specimens of the species and of the species now in the synonymy. The following paragraph contains entirely non-typical material.

*Barbus acuticeps* M.A.C.T. 130313 (holotype) ; 130310–312 ; 130314 (paratypes).

M.A.C.T. 91755–6, 92214.

*Barbus alluaudi* M.H.N.P. 09–586, 09–587 (syntypes).

*Barbus altianalis* B.M. (N.H.) 1906.9.6 : 13 (lectotype of *Barbus altianalis altianalis*) ; 1906.9.7 : 41 (holotype of *Barbus altianalis eduardianus*) ; 1904.5.19 : 13 (holotype of *Barbus altianalis radcliffii*) ; 1906.5.30 : 117–121 ; 1906.9.6 : 14–15 ; 1906.9.7 : 41 ; 1906.9.7 : 42–43 ; 1911.3.3 : 5 ; 1929.1.24 : 84 ; 1929.1.24 : 105–108 ; 1929.1.24 : 191–192 ; M.H.N.P. 30–118 ; 35–153 ; Z.M.H. 19052.

B.M. (N.H.) 1906.5.30 : 107–115 ; 1912.10.15 : 15–19 ; 1912.10.31 : 1 ; 1925.8.7 : 1–2 ; 1928.1.25 : 12 ; 1928.5.24 : 18–25 ; 1932.6.13 : 280–289 ; 1932.6.13 : 312–320 ; 1932.6.13 : 332 ; 1938.12.6 : 19 ; 1957.10.1 : 1–9 ; 1962.7.26 : 1–14 ; 1965.11.7 : 7–10 ; 1966.6.3 : 192 ; 1966.9.1 : 1 ; 1966.9.1 : 2–4 ; 1967.5.17 : 52–60 ; 1971.1.5 : 121–133 ; 1971.2.19 : 28–57 ; 1971.8.31 : 7–12 ; 1971.8.31 : 28–39 ; M.H.N.P. 35–143, 144 ; M.A.C.T. 66182 ; 66183 ; 92608 ; 91118–91122 ; 129096 ; Z.M.H. 19052.

*Barbus bynni* B.M. (N.H.) 1907.12.2 : 1230 (neotype) ; 1932.6.13 : 300–303 ; M.S.N.G. 17333 ; M.H.N.P. 05–275.

B.M. (N.H.) 1861.9.9 : 39–43 ; 1861.9.9 : 64 ; 1862.6.17 : 117–122 ; 1862.6.17 : 130–131 ; 1905.10.26 : 11 ; 1907.12.2 : 1181–1229 ; 1907.12.2 : 1231–1251 ; 1907.12.2 : 3721–3728 ; 1908.1.20 : 111–116 ; 1908.11.7 : 1 ; 1929.1.24 : 109–112 ; 1937.4.20 : 7–9 ; 1968.7.24 : 37 ; 1970.12.15 : 1 ; M.S.N.G. 17337 ; P.A.S. 16710.

*Barbus caudovittatus* M.A.C.T. 1168 (holotype) ; B.M. (N.H.) 1901.12.26 : 26 (paratype) ; 1919.7.24 : 7 ; 1919.7.24 : 8–9.

B.M. (N.H.) 1920.5.26 : 75–76 ; 1936.6.15 : 643–644 ; M.A.C.T. 6785 ; 6786 ; 6992 ; 14551 ; 15410 ; 15584 ; 39456 ; 43823 ; 44446–44461 ; 44482 ; 44483 ; 44551–44563 ; 47341 ; 48504 ; 48505 ; 50061–62 ; 56416 ; 56417 ; 61304–63011 ; 74754 ; 77407 ; 78927 ; 78928 ; 81618 ; 81619 ; 81620 ; 81622–31 ; 81632–35 ; 81637–81656 ; 81661–81984 ; 81988 ; 91117 ; 92561 ; 92562 ; 92563–78 ; 92608 ; 94318 ; 96108–114 ; 99654 ; 102024 ; 121781–826 ; 124937 ; 125774–780 ; 129095 ; 130067 ; 130068 ; 131355 ; 134956 ; 134957 ; 138957 ; 148829 ; 148830 ; 148839 ; 153485 ; 160152–163 ; 160165–67 ; 164571 ; 166954.

*Barbus ethiopicus* B.M. (N.H.) 1971.7.12 : 1–3.

*Barbus gananensis* M.S.N.G. 17525 (holotype, not seen by me) ; M.S.N.G. 17331 ; 17339 ; 17341 ; 17342.

*Barbus intermedius* S.M.F. 6778 (holotype of *Barbus intermedius intermedius*) ; B.M. (N.H.) No. 18 in 1932.6.13 : 191–200 (holotype of *Barbus intermedius australis*) ; S.M.F. 2586 ; 2619 ; 6779 ; 6786 ; M.H.N.P. 05–252 ; 05–257 ; B.M. (N.H.) 1893.12.2 : 40–45 ; 1902.12.13 : 211–212 ; 1902.12.13 : 225–228 ; 1902.12.13 : 261–270 ; 1902.12.13 : 274–275 ; 1902.12.13 : 294 ; 1902.12.13 : 295–298 ; 1902.12.13 : 303–304 ; 1902.12.13 : 305–306 ; 1902.12.13 : 309 ; 1902.12.13 : 328–331 ; 1903.11.16 : 1–7 ; 1908.1.20 : 100 ; 1908.1.20 : 103–106 ; 1908.1.20 : 107–109 ; 1908.1.20 : 110 ; 1908.1.20 : 131–133 ; 1908.1.20 : 170 ; 1908.1.20 : 181–183 ; 1916.1.14 : 7 ; 1937.4.20 : 66.

B.M. (N.H.) 1893.12.2 : 46–47 ; 1901.6.24 : 83–85 ; 1902.12.13 : 229 ; 1902.12.13 : 231–250 ; 1902.12.13 : 277–283 ; 1902.12.13 : 284–290 ; 1902.12.13 : 308 ; 1902.12.13 : 311 ; 1902.12.13 : 312–315 ; 1902.12.13 : 317–319 ; 1902.12.13 : 320–326 ; 1902.12.13 : 332–337 ; 1902.12.13 : 339 ; 1902.12.13 : 357 ; 1908.1.20 : 86 ; 1908.1.20 : 91–95 ; 1908.1.20 : 97–99 ; 1908.1.20 : 101–102 ; 1908.1.20 : 117–130 ; 1908.1.20 : 134–155 ; 1908.1.20 : 157–168 ; 1908.1.20 : 171–180 ; 1912.3.22 : 50–60 ; 1912.11.11 : 9–10 ; 1932.6.13 : 191–200 (less the holotype of *Barbus intermedius australis*) ; 1932.11.5 : 246–60 ; 1937.4.20 : 29–37 ; 1937.4.20 : 39–60 ;

1937.4.20 : 65 ; 1959.12.15 : 82–86 ; 1968.7.24 : 3–7 ; 1968.7.24 : 9–17 ; 1968.7.24 : 20–48 ; 1971.8.31 : 15–16 ; P.A.S. 14541 ; 14542.

*Barbus longifilis* M.H.N.P. 35–150 (lectotype) ; 35–145 – 149 ; 35–151 ; 35–152.
M.H.N.P. 35–67 ; M.A.C.T. 42934.

*Barbus macrolepis* Z.M.H. H331 (lectotype).
B.M. (N.H.) 1909.2.25 : 8 ; 1922.4.18 : 13 ; 1971.6.22 : 131–134. 1972–11.28 : 9–12.

*Barbus mariae* holotype not seen.
B.M. (N.H.) 1936.12.22 : 35–39 ; 1937.6.4 : 16.

*Barbus microbarbis* M.A.C.T. 41847 (holotype).

*Barbus microterolepis* B.M. (N.H.) 1902.12.13 : 220 (holotype).

*Barbus mirabilis* Z.M.B. 19059 (holotype).

*Barbus oxyrhynchus* Z.M.H. H339 (lectotype) ; B.M. (N.H.) 1893.12.2 : 24–29 ; 1893.12.2 : 32–34 ; 1893.12.2 : 37–39 ; 1902.5.26 : 25–28 ; 1902.5.26 : 35–38 ; 1906.8.25 : 7–9 ; M.H.N.P. 26–285 ; S.M.N.H. 9238 ; F.M.C. 6108 ; 6109 ; Z.M.H. 340.
B.M. (N.H.) 1893.12.2 : 30 ; 1893.12.2 : 35 ; 1902.5.26 : 29–34 ; 1904.1.30 : 5–18 ; 1904.10.10 : 2–4 ; 1904.12.23 : 48–49 ; 1906.8.25 : 6 ; 1906.8.25 : 10–16 ; 1908.9.17 : 8–12 ; 1909.11.15 : 43–47 ; 1914.9.21 : 4 ; 1915.12.2 : 2–20 ; 1936.12.22 : 2 ; 1936.12.22 : 30–34 ; 1937.12.11 : 1–4 ; 1937.6.4 : 15 ; 1959.12.15 : 81 ; 1965.11.1 : 7–12 ; 1966.6.3 : 252 ; 1969.3.24 : 10 ; 1969.3.24 : 44–50 ; 1971.5.10 : 55 ; 1971.8.12 : 2–6 ; F.M.C. 6110 ; M.A.C.T. 47341 ; S.M.N.H. 8061 ;

*Barbus pagenstecheri* Z.M.H. H.342 (lectotype), H.341 (paralectotype).

*Barbus paucisquamatus* M.H.N.P. 35–76 (lectotype).
M.H.N.P. 35–77 ; 35–78 ; 35–153 ; 35–154 ; 35–118 (3 specimens) ; M.A.C.T. 42932 ; 130145 ; 130146.

*Barbus platyrhinus* B.M. (N.H.) 1906.9.6 : 12 (holotype).
M.A.C.T. 89789–92 ; 130658–60.

*Barbus ruasae* Z.M.B. 19053 (lectotype, one of two specimens).
M.A.C.T. 91755 ; 91756 ; 92214.

*Barbus somereni* B.M. (N.H.) 1911.7.26 : 1 (holotype) ; M.A.C.T. 46963–65.
B.M. (N.H.) 1969.3.3 : 13–14 ; 1971.1.5 : 96–99 ; 1971.1.5 : 100–117 ; 1971.1.5 : 120 ; 1971.1.5 : 145 ; 1971.2.19 : 26–27 ; 1971.8.31 : 13–14 ; 1971.10.18 : 1–5 ; M.A.C.T. 46952–62 ; 46966–47339 ; 47342 ; 55788–792 ; 56456–478 ; 56480–91 ; 71781–82 ; 73157–73162 ; 87692–695 ; 87696–698 ; 94221–232 ; 92579–89 ; 92591–92607 ; 93356–377 ; 129108.

*Barbus stappersii* M.A.C.T. 14250 (holotype) ; 14765 ; 14233 ; 14172.
M.A.C.T. 81945 ; 81985 ; 122295 ; 138958–959.

*Barbus trachypterus* M.A.C.T. 81621 (holotype).
M.A.C.T. 129097–100 ; 165254–256.

*Barbus tropidolepis* B.M. (N.H.) 1906.9.6 : 19–21 (the smallest specimen is the lectotype).
B.M. (N.H.) 1906.9.8 : 50–52 ; 1920.5.25 : 38–46 ; 1936.6.15 : 568–629 ; 1955.12.20 : 720–731 ; 1955.12.20 : 733–815 ; 1955.12.20 : 873 ; 1955.12.20 : 888 ; 1955.12.20 : 1169–1171.

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The generic name *Barbus* has been omitted from this list. Where the genus is not *Barbus* it is *Varicorhinus* and is symbolized by *V*.

*acuticeps* Matthes 1959, 5
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*affinis brevibarbus* Bini 1940 = *B. intermedius intermedius*, 47
*affinis nedgia* Bini 1940 = *B. intermedius intermedius*, 47
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*altianalis eduardianus* Worth. 1932, 9
*altianalis radcliffii* Worth. 1932, 9
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*Printed in Great Britain by John Wright and Sons Ltd. at The Stonebridge Press, Bristol BS4 5NU*

# SOME DIGENETIC TREMATODES IN FISHES FROM THE BAY OF BISCAY AND NEARBY WATERS

BRITISH MUSEUM
-7 JUN 1973
NATURAL HISTORY

R. A. BRAY

BULLETIN OF
THE BRITISH MUSEUM (NATURAL HISTORY)
ZOOLOGY Vol. 26 No. 2
LONDON: 1973

BRITISH MUSEUM
-7 DEC 1973
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BY

RODNEY ALAN BRAY

*Pp* 149–183 ; 11 *Text-figures*

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THE BULLETIN OF THE BRITISH MUSEUM (NATURAL HISTORY), *instituted in* 1949, *is issued in five series corresponding to the Departments of the Museum, and an Historical series.*

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*World List* abbreviation :
*Bull. Br. Mus. nat. Hist.* (Zool.)

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TRUSTEES OF
THE BRITISH MUSEUM (NATURAL HISTORY)

*Issued* 15 *November*, 1973 *Price* £1.60

# SOME DIGENETIC TREMATODES IN FISHES FROM THE BAY OF BISCAY AND NEARBY WATERS

*By* RODNEY A. BRAY

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## SYNOPSIS

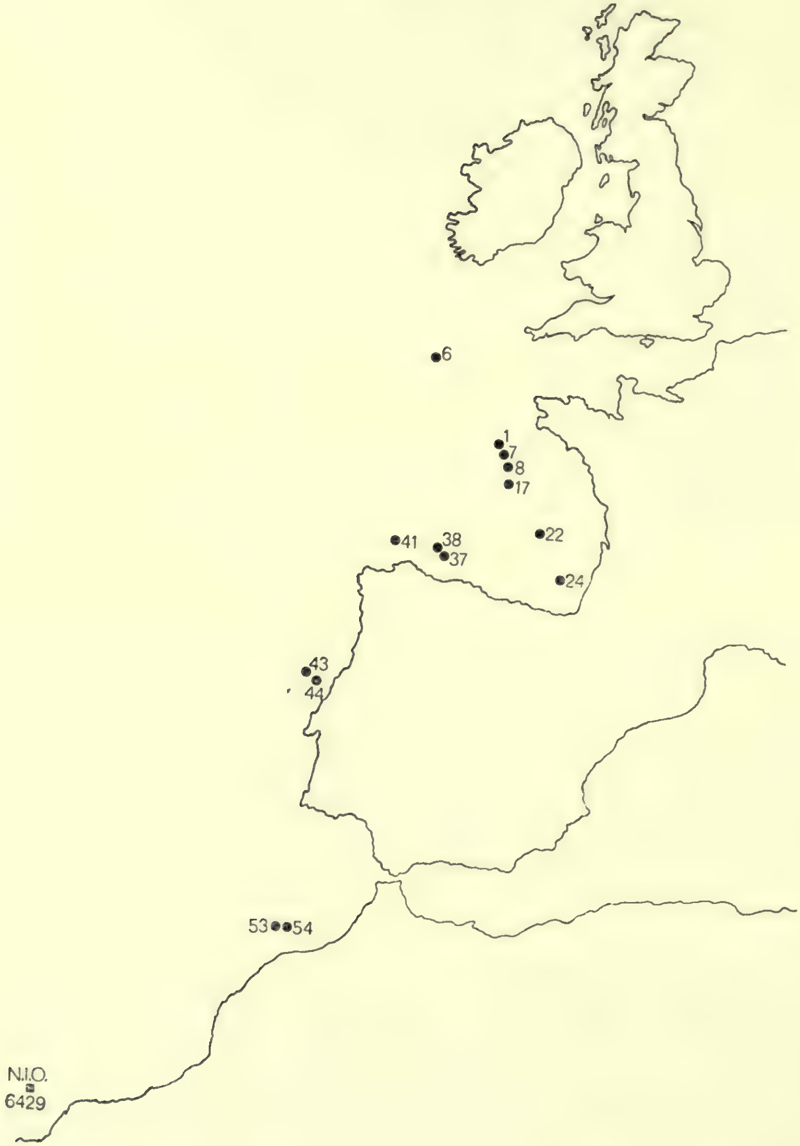
Sixteen species of digenetic trematodes are recorded from seventeen species of fishes caught in the Bay of Biscay and in waters off the north-west coast of Spain and the Atlantic coast of Morocco.

The following two species are described as new : *Bathycreadium biscayense* and *Steringophorus blackeri*. Seven of the remaining species are described, these are *Dolichoenterum longissimum* Ozaki, *Prosorhynchus crucibulum* (Rud.), *Lepidapedon rachion* (Cobbold), *L. elongatum* (Lebour), *Steganoderma abyssorum* (Odhner), *Neosteganoderma glandulosum* Byrd and (?) *Steringotrema divergens* (Rud.). The following new combinations are made : *Bathycreadium* [*Nicolla*] *elongatum* (Maillard) and *Neosteganoderma* [*Proctophantastes*] *polymixiae* (Yamaguti).

## INTRODUCTION

THE author was given the opportunity in 1971 to obtain parasitic worms from marine fishes, whilst accompanying a cruise of the Ministry of Agriculture, Fisheries and Food Research Vessel 'Cirolana', the primary purpose of which was to collect blood from hake for electrophoretic and chromosome studies. The collecting was carried out between the 1st and the 14th of January and was conducted primarily in the Bay of Biscay, but also in other areas, including the waters off the western coasts of Spain and Morocco. The locations of the stations mentioned in this report are shown on Fig. 1 and further details are given in Table 1.

The fish were caught by stern trawl and the alimentary tract removed from them. The stomach and intestine were separated before being opened up with scissors, and then the contents were shaken into a tube of sea-water. These tubes were kept for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6429

FIG. 1. Map showing positions of stations mentioned in this report.

TABLE I

Station List

| Station No. | Date Jan. 1971 | Shot Time (BST) | Shot Latitude north | Shot Longitude west | Shot Depth (m) | Haul Time (BST) | Haul Latitude north | Haul Longitude west | Haul Depth (m) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1st | 1505 | 47°10′ | 05°40′ | 650 | 1710 | not recorded | – | – |
| 6 | 2nd | 1915 | 48°31′ | 08°51′ | 177 | 2015 | 48°28′ | 09°11′ | 173 |
| 7 | 3rd | 1010 | 47°02′ | 05°40′ | 330 | 1230 | 47°03′ | 05°33′ | 610 |
| 8 | 3rd | 1630 | 46°55′ | 05°18′ | 520 | 1730 | 46°51′ | 05°18′ | 680 |
| 17 | 4th | 1940 | 46°47½′ | 05°08′ | 348 | 2140 | 46°42½′ | 04°58½′ | 480 |
| 22 | 5th | 1810 | 45°25½′ | 03°16′ | 420 | 2025 | 45°17½′ | 03°13′ | 680 |
| 24 | 6th | 0925 | 44°23′ | 02°12′ | 575 | 1225 | 44°38′ | 02°12′ | 665 |
| 37 | 8th | 1230 | 45°54½′ | 06°36′ | 340 | 1410 | 43°49½′ | 06°33′ | 350 |
| 38 | 8th | 1715 | 43°52½′ | 06°36′ | 280 | 1915 | 43°55½′ | 06°44′ | 272 |
| 41 | 9th | 0830 | 43°58½′ | 08°23′ | 252 | 1030 | 43°57½′ | 08°32′ | 304 |
| 43 | 10th | 1315 | 40°03½′ | 09°42′ | 450 | 1515 | 40°11′ | 09°47′ | 460 |
| 44 | 10th | 1640 | 40°13′ | 09°37′ | 290 | 1840 | 40°04′ | 09°38′ | 256 |
| 53 | 14th | 0845 | 33°45′ | 08°36′ | 236 | 1030 | 33°42½′ | 08°40′ | 222 |
| 54 | 14th | 1130 | 33°43′ | 08°36′ | 360 | 1340 | 33°47½′ | 08°26′ | 408 |

periods of up to six hours in a refrigerator at just above freezing point, before being topped up with a fixative, either 'Dowicil' or 10 per cent formalin. A degree of contraction resulted from the use of these fixatives.

The material from the 'Cirolana' cruise was supplemented by two trematodes collected from preserved fish in the collection of the National Institute of Oceanography (now the Institute of Oceanographic Sciences) at Wormley, Surrey.

The parasites of seventeen species of fish are mentioned in this report. The majority of the sixteen species of digenetic trematodes studied are already well known as widespread species. It is interesting to note, however, that *Neosteganoderma glandulosum*, reported originally from Florida, has now been recovered from off the north-west coast of Spain and that *Steganoderma abyssorum*, previously reported only from Norway, occurs in the eastern Bay of Biscay. Further evidence of the affinities of species in the area under discussion with Florida on one hand, and the north-eastern North Atlantic on the other, is indicated by the finding of two new species whose closest relatives appear to be species from these two areas.

## HOST-PARASITE LIST

*Alosa fallax* (Lacépède) – *Hemiurus appendiculatus* (Rud.).
*Beryx decadactylus* Cuvier – *Neosteganoderma glandulosum* Byrd.
*Capros aper* (L.) – (?) *Steringotrema divergens* (Rud.).
*Coelorinchus caelorhinchus* (Risso) – *Bathycreadium biscayense* sp. nov.
    *Steganoderma abyssorum* (Odhner).
*Conger conger* (L.) – *Dolichoenterum longissimum* Ozaki.
    *Prosorhynchus crucibulum* (Rud.).
    *Lecithochirium gravidum* Looss.
*Dalatias licha* (Bonnaterre) – *Otodistomum veliporum* (Creplin).
*Gaidropsarus vulgaris* (Cloquet) – *Helicometra fasciata* (Rud.).
*Lepidion eques* (Günther) – *Bathycreadium biscayense* sp. nov.
    *Lepidapedon elongatum* (Lebour).
    *Steganoderma abyssorum* (Odhner).
*Lophius piscatorius* L. – *Bucephalopsis gracilescens* (Rud.).
*Merluccius merluccius* (L.) – *Derogenes varicus* (Müller).
*Micromesistius poutassou* (Risso) – *Derogenes varicus* (Müller).
*Molva macrophthalma* (Rafinesque-Schmaltze) – *Derogenes varicus* (Müller).
*Phycis blennoides* (Brünnich) – *Lepidapedon rachion* (Cobbold).
    *Derogenes varicus* (Müller).
*Scomber scombrus* L. – *Lecithocladium excisum* (Rud.).
*Trachyrhynchus trachyrincus* (Risso) – *Bathycreadium biscayense* sp. nov.
    *Lepidapedon elongatum* (Lebour).
    *Steganoderma abyssorum* (Odhner).
    *Derogenes varicus* (Müller).
*Xenodermichthys copei* (Gill) – *Steringophorus blackeri* sp. nov.
*Xenodermichthys* sp. indet. – *Steringophorus blackeri* sp. nov.

## SYSTEMATIC SECTION

### Family **BUCEPHALIDAE** Poche, 1907

### ***Dolichoenterum longissimum*** Ozaki, 1924

(Fig. 2)

Host and locality : intestine of *Conger conger*, Stn. 7.

Twenty-three specimens were found, and these vary from 3·5 to 6·5 mm in length. The longer worms are less contracted and have a long narrow neck, and an elongate oval hindbody (Fig. 2a), but in the shorter contracted specimens there is little indication of a neck (Fig. 2b). Whilst, superficially, these two forms may appear distinct an examination of the internal morphology of the worms leaves no doubt that they are specifically identical. The cuticle has, imbedded in it, numerous narrow pointed spines.

The anterior sucker is surmounted by a thick muscular hood, which in an extended condition, bears seven to eight horn-like conical projections on the dorsal and lateral rims (Figs. 2c and d). In an extended condition the sucker is 0·53–0·68 mm in diameter. When contracted the sucker becomes almost globular, and the projections are less conspicuous, and apparently less numerous in some cases, and point inwards. The sucker in this condition measures 0·32–0·44 mm in diameter. The aperture of the sucker is subterminal, with a more or less narrow extension down the ventral surface.

The contraction or expansion of the worm also affects the anterior portion of the alimentary canal. In neither whole mounts nor serial sections was evidence of an oral sucker seen. The specimens lacking a neck bear a simple mouth situated closely behind the anterior sucker. A short prepharynx runs posteriorly to the somewhat transversely-oval pharynx measuring 0·3–0·32 mm × 0·21 mm. From the pharynx the intestine runs anteriorly to a point which may or may not be nearer to the anterior sucker than the pharynx, where it turns conversely to reach the hinder end of the body. In both extended and contracted specimens the intestine follows a transversely undulating course and reaches nearly to the posterior end of the cirrus-sac. The posterior limit of the intestine is not easy to make out in whole mounts as it is often obscured by the eggs in the uterus.

A sinus occurs at the posterior margin of the worm, normally in the median line, though contraction has, in some cases, displaced the opening to the left of the median line. Into it open the ducts of the male and female systems and of the excretory vesicle. The opening of the sinus does not appear to be surrounded by a sphincter. The elongate cirrus-sac, which, due to contraction, lies at an acute angle to the median line, measures 0·95 × 0·23–0·28 mm and possesses a fairly thick muscular wall. It contains an oval seminal vesicle, 0·38–0·43 mm × 0·23–0·25 mm, which occupies the anterior portion of the cirrus-sac. The pars prostatica passes out of the middle region of the seminal vesicle, and runs to near the posterior extremity of the cirrus-sac where it unites with a short muscular cirrus. The testes are transversely elongate, well separated one behind the other, and are situated in the

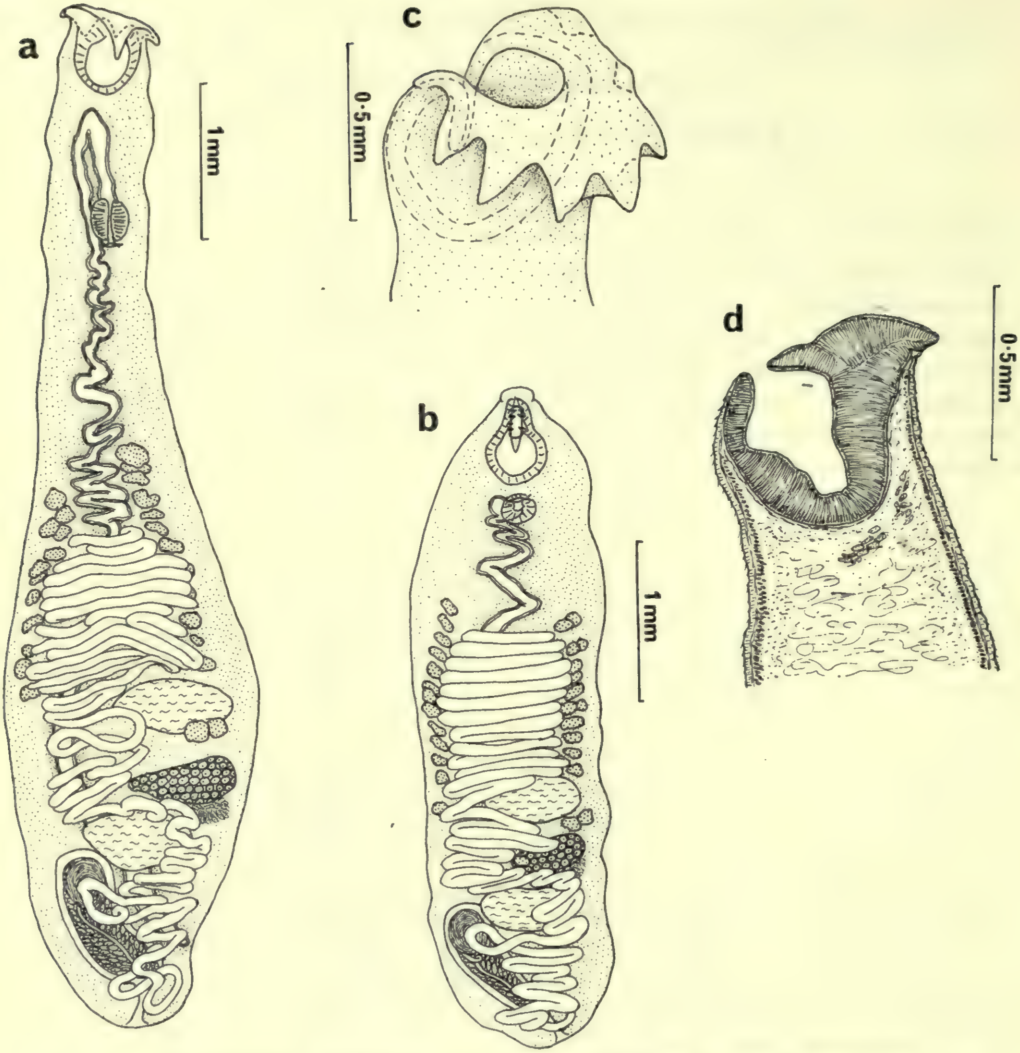

Fig. 2. *Dolichoenterum longissimum* Ozaki: a) extended specimen (ventral view); b) contracted specimen (ventral view); c) anterior sucker (dorso-lateral view); d) longitudinal section of anterior sucker.

middle region of the hinder half of the body. They are 0·56–0·84 mm × 0·22–0·41 mm. The ovary is also transversely elongate measuring 0·53–0·82 mm × 0·23–0·34 mm, and lies a little to the left of the median line between the testes. Directly behind it lies a large diffuse Mehlis' gland. Laurer's canal opens dorsally at about the level of the posterior testis. There appears to be no receptaculum seminis, but sperm is accumulated in the initial slings of the uterus, which is long and coiled running to a position some way anterior to the anterior testis before it turns and passes posteriorly, with many tightly-packed transverse slings. It passes into the posterior region of the body, where it opens into the base of the genital sinus near the cirrus-sac, via a short muscular metraterm. There are numerous small eggs, many of which are collapsed, but measuring 21–27 μm × 12–18 μm when not collapsed. The vitelline follicles lie in two lateral groups, with about 12–16 follicles in each group, extending from about the level of the anterior testis to a position anterior to the foremost extent of the uterus. A few follicles also occur scattered between the testes.

The excretory vesicle opens into the genital sinus, and runs forward to a position just posterior to the posterior testis.

*Dolichoenterum longissimum* was originally described from *Conger myriaster* in Japanese waters. It has been found a number of times since in the same waters in *C. myriaster* (Ozaki 1928 ; Yamaguti 1938 ; Machida *et al.* 1970) and in *Muraenesox cinereus* (Yamaguti 1934). Prior to the present record, it has also been found in *Conger conger* in New Zealand waters (Manter 1954) and in two localities off the western coast of Scotland (Williams 1960).

Ozaki (1928) and Yamaguti (1934) disagree on the presence of a so-called 'urogenital' pore, that is, the common opening of the genital sinus and the excretory vesicle. Yamaguti states that Ozaki's figure 23 is misleading, and suggests that the 'genital sinus' is no more than a slight depression. Ozaki's figure, however, seems to accurately represent the condition in the present material. It would seem that the depth of the genital sinus is influenced somewhat by the contraction of the body.

Another feature which varies with the condition of the worm is the number and configuration of the projections surmounting the anterior sucker. Such a difference is, according to Tendeiro (1955), a major factor in separating *D. manteri* Tendeiro, 1955 (with only five projections) from *D. longissimum.* Tendeiro found a single specimen of *D. manteri* in *C. conger* from the Algarve coast of Portugal, and considered it distinct for a number of other reasons. The only one of these that appears to be a valid differentiating feature is the length of the intestine, which in *D. manteri* is said to extend only a little behind the middle region of the body. As Tendeiro had but one specimen it may have been that, as is the case in many of my specimens, it was not possible to trace the full extent of the intestine. If this were found to be so, then it seems probable that *D. manteri* should be considered a synonym of *D. longissimum.*

### ***Bucephalopsis gracilescens*** (Rud., 1819) Nicoll, 1914

Host and locality : intestine of *Lophius piscatorius*, Stn. 54.

This parasite occurred in great numbers. The shape of these worms varies considerably as indicated by Dawes (1947).

### ***Prosorhynchus crucibulum*** (Rud., 1819) Odhner, 1905

(Fig. 3)

*Monostoma crucibulum* Rud., 1819.
*Distoma crucibulum* : Dujardin, 1845.
*Gasterostomum crucibulum* : Gervais and van Beneden, 1859.

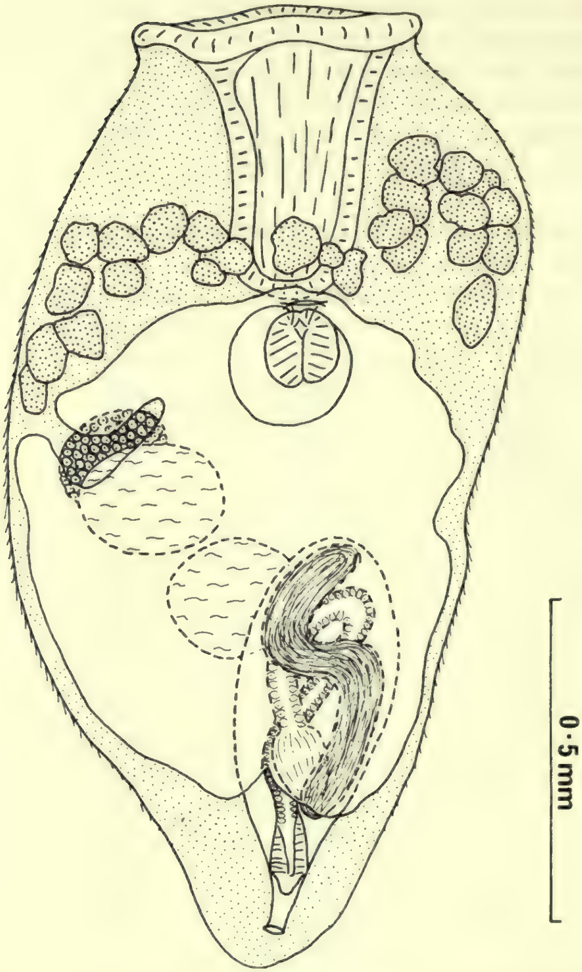

FIG. 3. *Prosorhynchus crucibulum* (Rud.) : ventral view.

Host and locality : intestine of *Conger conger*, Stn. 7.

A single specimen was present, and it was examined as a whole mount and then in serial sections. It is a small worm, truncated anteriorly and pointed posteriorly, 1·5 mm in length and 0·87 mm in maximum width. The cuticle bears numerous scale-like spines. At the anterior end there is a muscular, funnel-shaped rhynchus, 0·48 mm across at its widest point and extending posteriorly to very near the intestine, that is, about 0·55 mm from the anterior end of the worm. A slit-like transverse mouth, 52 μm across, is situated at about the anterior third of the body length, and near the base of the rhynchus. It leads immediately to a nearly globular pharynx, measuring 0·108 × 0·115 mm, which in turn leads into a muscular oesophagus

0·07 mm long, thence into the saccular intestine, which lies dorsally to the pharynx and is about 0·2 mm × 0·16 mm.

The excretory pore is terminal posteriorly, and the excretory vesicle reaches to about the level of the anterior end of the cirrus-sac.

The genital sinus opens near to the posterior extremity of the body on the ventral side of the worm. A muscular cirrus-sac, 0·47 mm long by about 0·22 mm wide, reaches anteriorly to a position just in front of the anterior margin of the posterior testis. It contains a sigmoid seminal vesicle, which extends from the foremost extremity of the cirrus-sac to a position near to the posterior extremity, where it forms a muscular bulb before passing into an elongate pars prostatica. This latter organ runs nearly to the anterior of the cirrus-sac before passing posteriorly to where it unites with a relatively short muscular cirrus, which opens into the sinus at the base of the genital tongue. There is no indication of an external seminal vesicle. The testes lie one just posterior to the pharynx with the other just behind it. They are oval with smooth margins and measure 0·27 × 0·19 mm (anterior testis) and 0·21 × 0·2 mm (posterior testis). The ovary, of similar size and shape to the testes (0·2 mm dia.), lies just antero-dorsal to the anterior testis. The 'shell'-gland lies immediately posterior to the ovary, and Laurer's canal opens dorsally just posterior to the ovary. The vitellaria consist of about 25 irregular follicles lying more or less in an arc just behind the rhynchus and anterior to the pharynx and uterus. This latter organ is extensive in the region posterior to the pharynx, obscuring parts of the reproductive system in the whole mount. A short, muscular metraterm enters the genital sinus dorsally to the cirrus-sac. The eggs, which are very numerous and mostly collapsed, measure about 24–26 μm × 16–18 μm.

*Prosorhynchus crucibulum* is a common parasite of the conger and is morphologically very similar to another parasite of this fish, *P. aculeatus* Odhner, 1905, with which it has been synonymized by Dawes (1947). Brinkmann (1957) has given a number of reasons why he considers these species to be distinct, and, having examined a number of specimens assigned to both species in the collections of the British Museum (Natural History), I agree that the features selected by Brinkmann appear to be of value in distinguishing these species. The most noticeable difference is the size and shape of the rhynchus, which in *P. aculeatus* is small and rounded, and in *crucibulum* is larger and triangular or funnel-shaped. This character appears to be fairly constant, and according to Matthews (1973) the typical shape of the rhynchus in *P. crucibulum* is developed in the metacercaria during its first month in the second intermediate host. As can be seen, the present specimen fits *P. crucibulum* in this, as well as the other less prominent characteristics.

## Family **OPECOELIDAE** Ozaki, 1925

### ***Helicometra fasciata*** (Rud., 1819) Odhner, 1902

Host and locality: intestine of *Gaidropsarus vulgaris*, Stn. 22.

One specimen was present.

### ***Bathycreadium biscayense*** sp. nov.

(Fig. 4)

Hosts and localities : caeca and intestine of *Trachyrhynchus trachyrincus* (type-host), Stn. 7, Stn. 24 ; caeca and intestine of *Coelorinchus caelorhinchus*, Stn. 1 ; intestine of *Lepidion eques*, Stn. 1.

This species occurred commonly in *T. trachyrincus*, in smaller numbers in *C. caelorhinchus* and only one specimen was found in *L. eques*.

The worm is elongate oval with lateral margins roughly parallel for much of its length, which varies between 0·4 mm and 1·7 mm. The maximum width, which normally occurs at the level of the ventral sucker, is 0·19–0·42 mm. The tegument is not armed, but bears annular wrinkles, probably due to contraction. Circular and subterminal, the oral sucker measures 0·065–0·14 mm in diameter and leads, without an apparent prepharynx, into a globular pharynx 0·032–0·066 mm in diameter. The oesophagus, up to 0·13 mm in length and lined with a cuticle, bifurcates at about the anterior margin of the ventral sucker. The intestinal caeca reach to near the posterior end of the worm, where they unite to form a cyclocoel. The ventral sucker is situated close behind the oral sucker in the anterior quarter or third of the body. It is often situated on a slight protuberance, and is transversely elongate, its transverse diameter being 0·19–0·29 mm, thus giving an oral : ventral sucker ratio of 1 : 2·2–3·5.

The excretory pore is terminal, and the cylindrical vesicle reaches to the ovary.

The genital pore occurs just to the left of the median line, closely anterior to the ventral sucker. Into it opens a claviform cirrus-sac measuring 0·25–0·4 mm × 0·05–0·085 mm, which normally reaches just posteriorly to the ventral sucker, and its posterior extremity lies amongst the uterine coils. It contains a convoluted internal seminal vesicle, a relatively short, oval pars prostatica and a long muscular cirrus. The testes are situated in tandem, close together, in the middle third of the body. They are usually wider than long with entire or slightly indented margins and measure in mature specimens 0·08–0·12 mm × 0·12–0·15 mm (anterior testis) and 0·09–0·12 mm × 0·12–0·15 mm (posterior testis).

The ovary is situated anteriorly and adjacent to the foremost testis, usually in the median line, but sometimes moved to one side or the other by the development of the uterus. It is normally wider than long, oval, with smooth margins and measures 0·025–0·065 × 0·083–0·1 mm. There appears to be a seminal receptacle lying dorsally to the ovary, but, despite several attempts, it has not been possible to obtain satisfactory serial sections of the female complex, so whether this is a true seminal receptacle or part of the uterus has not been determined, nor has the course of Laurer's canal, if present. The vitellaria consist of numerous oval follicles in lateral fields reaching from about the posterior border of the ventral sucker to near the posterior end of the worm. Behind the posterior testis the fields meet in the ventral plane, and come close together in the dorsal, being separated only by the excretory vesicle. Between the testes, and between the anterior testis and the ovary the follicles may extend towards the median line, but do not reach it. The vitelline fields are sometimes interrupted opposite the ovary and the testes. The

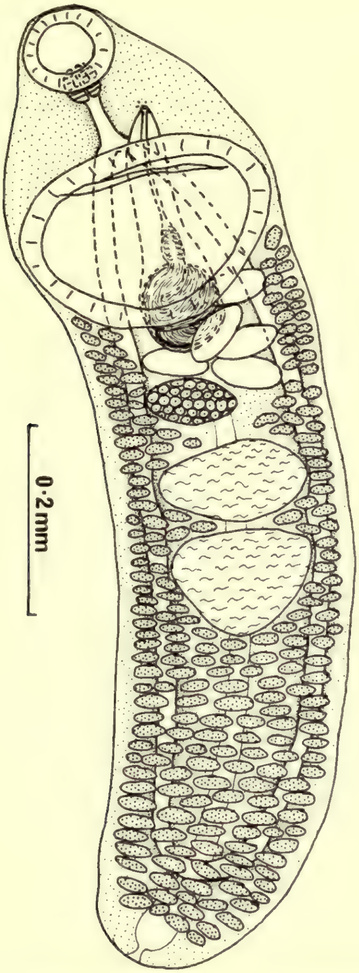

FIG. 4. *Bathycreadium biscayense* sp. nov. : specimen from *Trachyrhynchus trachyrincus* (ventral view).

uterus runs from the ovary to the posterior margin of the ventral sucker, and contains a few (up to about 10) large eggs. These measure 80–92 μm × 43–52 μm.

MATERIAL. British Museum (Nat. Hist.) Reg. no. 1973.4.9.1–20 (syntypes).

*Bathycreadium* Kabata, 1961, has been reduced to synonymy with *Nicolla* Wisniewski, 1933, by Slusarski (1971). Kabata did not compare the two genera so it was left to Pritchard (1966) to list the differences between them. Slusarski dismisses Pritchard's diagnostic characters by saying that they are too variable in *Nicolla*, and he is probably correct in this assumption in respect of most of these characters. It does seem, however, that at least one character mentioned by Pritchard may be used in separating these two genera, along with another feature she did not mention.

As she noted, it appears that in all the species of *Nicolla* (with one exception, i.e. *N. elongata*) the vitellaria reach anteriorly to the ventral sucker, whilst in *Bathycreadium* they do not reach further forward than the posterior margin of the ventral sucker. It is also apparent that the normal situation of the posterior testis in *Nicolla* is close to, or contiguous with, the cyclocoel with few or no vitelline follicles between the posterior testis and the intestinal arch (again *N. elongata* is an exception). In *Bathycreadium* there is at least a testis diameter, usually considerably more, between the posterior testis and the cyclocoel, and the bulk of the vitellaria is in this region. From its differentiating characteristics it is evident that *Nicolla elongata* Maillard, 1970, from *Onos tricirratus* in the Gulf of Lion should be assigned to *Bathycreadium elongatum* (Maillard, 1970) n. comb.

It may also be mentioned here that the concept of *Bathycreadium* as given above is close to that of *Coitocaecum* Nicoll, 1915, as represented by Yamaguti (1971). He seems to be in error, however, in stating that the cirrus-sac is 'retort-shaped containing elongate saccular or tubular seminal vesicle, prostatic complex and ejaculatory duct' in *Coitocaecum*. The type-species of this latter genus, *C. gymnophallum* Nicoll, 1915, has, according to the original author, 'no true cirrus-pouch', while Crowcroft (1951) who re-examined Nicoll's material states that there is 'a small membranous cirrus-sac enclosing a short, terminal portion of the male duct'.

*B. biscayense* differs from the other two species in the genus, *B. flexicollis* Kabata, 1961, and *B. elongatum* (Maillard, 1970), in the anterior extent of the vitellaria, in the proximity of the testes and the ovary and in the sucker-ratio. It also appears that it normally contains fewer eggs than the other species. The egg-size of *B. biscayense* differs greatly from that of *B. elongatum*, but is similar to that of *B. flexicollis* as corrected by Pritchard (1966) and verified by the author from paratype specimens in the collections of the British Museum (Natural History).

## Family **LEPOCREADIIDAE** Nicoll, 1935

### ***Lepidapedon rachion*** (Cobbold, 1858) Stafford, 1904

(Fig. 5)

*Distomum rachion* Cobbold, 1858.
*Lepodora rachiaea* : Odhner, 1905.

Host and locality : intestine of *Phycis blennoides*, Stn. 17.

Nine contracted specimens were present. They are small worms 0·66–1 mm long and 0·27–0·44 mm wide, being widest behind the ventral sucker, and tapering towards the anterior end. The cuticle bears rows of closely-set narrow pointed spines. The oral sucker is subterminal, measuring 0·097–0·115 mm in diameter, and leads into a prepharynx which, when apparent, varies in length up to 44 μm and is usually, but not invariably, longer than the oesophagus, which may reach a length of 28 μm. The pharynx is large and pyriform 0·09–0·13 mm × 0·066–0·106 mm. The intestinal bifurcation occurs close to the ventral sucker, and the caeca, which reach to the posterior end of the body, are wide. The rounded ventral sucker lies in the anterior

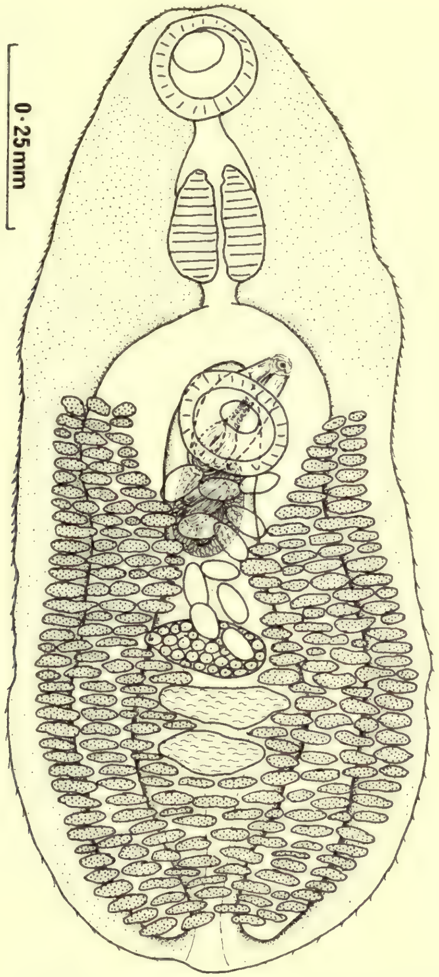

FIG. 5. *Lepidapedon rachion* (Cobbold) : ventral view.

half of the worm, and measures 0·08–0·12 mm in diameter, giving an oral : ventral sucker ratio of 1 : 0·75–1·08. Only in the largest specimen was the ventral sucker slightly larger than the oral, whilst in the other specimens the oral sucker was distinctly larger than the ventral.

The excretory pore is terminal and leads into a simple elongate excretory vesicle, which has been traced as far forward as the posterior testis.

The genital pore occurs closely anterior to the ventral sucker and to the left of the median line ; in fact, it lies ventrally to the left caecum. The muscular cirrus-sac reaches to near the posterior margin of the ventral sucker, measures about 0·09 mm in length and contains a coiled, tubular, seminal vesicle and a pars prostatica, which is slightly longer than the short muscular cirrus. The external seminal vesicle is also tubular and is coiled amidst a mass of gland-cells. This mass of cells extends behind the ventral sucker and is surrounded by a thin membrane. In the posterior third of the body lie the testes, in tandem formation. They are transversely elongate, have smooth or indented margins and measure 0·1–0·14 mm × 0·03–0·05 mm (anterior) and 0·08–0·14 mm × 0·04–0·06 mm (posterior).

The ovary lies just anteriorly to the foremost testis in the median line and is separated from the ventral sucker by the uterine coils. It is transversely elongate, measuring 0·08–0·13 mm × 0·04–0·07 mm, with smooth or slightly indented margins. Dorsal to the ovary lies a globular receptaculum seminis. The vitelline glands are numerous and reach anteriorly as far as about the middle level of the ventral sucker. They lie laterally and ventrally to the intestinal caeca and reach inwardly to the gonads, and although they intrude between the gonads they do not meet in the median line. Posteriorly to the testes, however, the vitelline fields are confluent in the median line. The uterine coils lie between the ovary and the ventral sucker and contain eggs, all of which, in the present specimens, are collapsed. In this condition they measure about 57–60 μm in length.

These worms are recognizable as *Lepidapedon rachion* despite the fact that, presumably due to contraction, the worms are on average shorter than is normal for this species. This parasite is fairly common in Gadidae in the northern Atlantic, but has not, apparently, been recorded from this host before.

## ***Lepidapedon elongatum*** (Lebour, 1908) Nicoll, 1910

(Fig. 6)

*Lepodora elongatum* Lebour, 1908.

Hosts and localities: intestine of *Lepidion eques*, Stn. 1; intestine of *Trachyrhynchus trachyrincus*, Stn. 1, Stn. 7, Stn. 24.

These worms were common in the intestine of both hosts. Their normal shape appears to be elongate oval, but some of the present specimens are contracted to a more pyriform shape, whilst some, taken from a frozen specimen of *L. eques*, are very elongate in the forebody. The length of the worm varies between 0·73 mm and 2·1 mm, and the width between 0·17 mm and 0·42 mm. The cuticle bears rows of narrow pointed spines. Rounded and subterminal, the oral sucker measures 0·09–0·17 mm in diameter. The ventral sucker, which is situated in the middle third of the body, is also rounded and measures 0·06–0·13 mm in diameter. The oral : ventral sucker ratio is 1 : 0·55–1. The prepharynx in grossly contracted specimens is not apparent, but in less contracted specimens it varies greatly in length, measuring up to 0·6 mm in one specimen from a frozen *L. eques*. Normally, the variation appears to be between about 0·01 mm and 0·1 mm. The pharynx is longer than wide, measuring 0·06–0·14 mm × 0·04–0·12 mm and has a tendency to be of a similar size to or somewhat larger than the ventral sucker. It leads into the oesophagus which, like the prepharynx, varies considerably in length, and is usually shorter than the prepharynx, being 0–0·06 mm in length. It bifurcates about midway

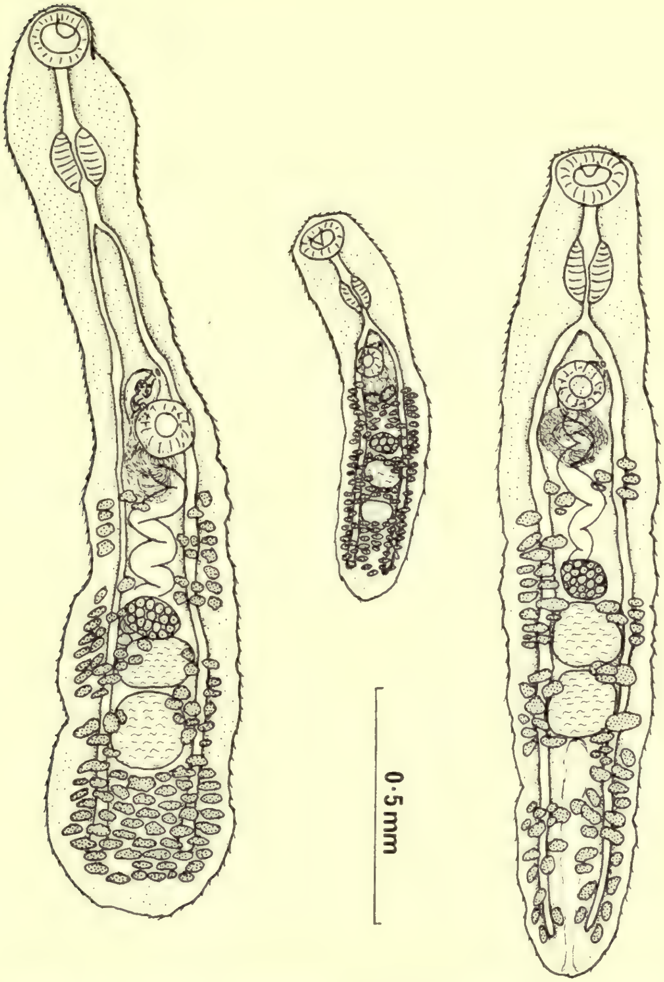

FIG. 6. *Lepidapedon elongatum* (Lebour) : three specimens from *Trachyrhynchus trachyrincus* (ventral view).

between the suckers or nearer to the ventral sucker. The caeca, lined with a deeply staining epithelium, reach to near the posterior end of the body.

The excretory pore is terminal and leads into a simple tubular vesicle which has been traced anteriorly to the level of the hinder margin of the hinder testis.

The genital pore is situated to the left of the median line close to the anterior margin of the ventral sucker or more further forward. The strongly muscular, oval cirrus-sac measures about 0·07–0·14 mm × 0·04–0·09 mm, but is not easy to measure satisfactorily due to the angle at which it lies to the body surface. It contains a coiled tubular seminal vesicle, a distinctly widened pars prostatica and a muscular cirrus. The internal seminal vesicle leads, via a narrow canal, into a convoluted external seminal vesicle surrounded by gland-cells. These cells are in turn surrounded by a very thin membrane, and reach to a position well posterior to the ventral sucker. The testes have smooth margins and are either transversely elongate or rounded. They are arranged in tandem at about the middle of the hindbody. The anterior testis measures 0·08–0·22 mm × 0·04–0·13 mm and the posterior 0·09–0·2 mm × 0·04–0·16 mm. There is a narrow space between the testes, and also between the anterior testis and the ovary, which lies in the median line, and is separated from the ventral sucker by the uterine coils. Like the testes it may be either transversely elongate or rounded, and measures 0·06–0·17 mm × 0·04–0·11 mm. The seminal receptacle lies dorsally to the ovary and Laurer's canal runs to the dorsal surface at about the same level. The vitelline glands do not reach anteriorly as far as the ventral sucker, but terminate on a level with the hinder end of the external seminal vesicle, or thereabouts. The follicles lie mostly in a plane ventral to the intestinal caeca, with some lateral to them. The lateral vitelline fields may be interrupted beside the ovary and testes and may reach to the median line between these organs, and also ventrally to the uterus. Behind the testes the fields usually merge in the median line, but sometimes the excretory vesicle appears to form a barrier between them. The uterus runs between the ovary and the ventral sucker, and opens into the genital atrium through a muscular metraterm of about the same length as the cirrus-sac. The uterus contains numerous eggs, the few uncollapsed ones measuring 58–65 μm long by about 30 μm wide.

Several authors have used the name *Lepidapedon elongatum* for specimens described from various species of fishes from the west and east coasts of North America (Manter 1926 ; Linton 1940 ; Ching 1961), the Pacific coast of Panama (Caballero y C. *et al.* 1955), Bombay (Gupta and Sehgal 1971), the Black Sea (Skrjabin and Koval 1960) and the Barents Sea (Dogiel 1936), in addition to those originally described from *Gadus morhua* on the Northumberland coast of England by Lebour (1908). The variation represented in these descriptions indicates that more than one species may be involved. The position is further complicated by the descriptions of very similar trematodes under other names, for example, *Lepidapedon coelorhynchi* Yamaguti, 1938, *L. gadi* (Yamaguti, 1934) and *L. microcotyleum* Dollfus, 1953. It seems that the latter two species may be distinguished from Lebour's form by egg-size, although their egg-size overlaps some of the later descriptions of '*L. elongatum*'. *L. coelorhynchi* was considered a synonym of *L. elongatum* by Hanson (1950) and this has been accepted by most subsequent authors.

The specimens described above differ from Lebour's description in that most of them have a ventral sucker distinctly smaller than the oral. She gives measurements of only one specimen, the ventral sucker being 0·12 mm across and the oral, 0·1 mm across. It should be noted, however, that in her figure the ventral sucker appears to be slightly smaller than the oral. The distribution of the vitellaria between the ovary and the ventral sucker is rather variable and probably not a good feature to use for differentiating species in this group, as was suggested by Polyanski (1955). Figure 6 illustrates variation in three specimens from the intestine of the same specimen of *T. trachyrincus*, but at the same time they also show a certain constancy of morphological features.

## Family **AZYGIIDAE** Odhner, 1911

### ***Otodistomum veliporum*** (Creplin, 1837) Stafford, 1904

Host and locality: intestine of *Dalatias licha*, Stn. 1.

This trematode has been reported from this host by a number of authors, including Dollfus (1937) who records it from the Bay of Biscay, off Biarritz, and also gives a list of previous records. Since then it has been found in this host in Norwegian waters by Bråten (1964) and in the Cook Strait, New Zealand, by Manter (1954).

## Family **ZOOGONIDAE** Odhner, 1911

### ***Steganoderma abyssorum*** (Odhner, 1911) Manter, 1947

(Fig. 7)

*Proctophantastes abyssorum* Odhner, 1911.
*Deretrema abyssorum*: Price, 1934.

Hosts and localities: intestine of *Trachyrhynchus trachyrincus*, Stn. 1, Stn. 7, Stn. 24; intestine of *Coelorinchus caelorhinchus*, Stn. 1, Stn. 37; intestine of *Lepidion eques*, Stn. 1.

The degree of contraction of the fixed worms varies considerably so that the shape varies from a very elongate pyriform to a short, broadly pyriform. The length is between 0·62 mm and 1·66 mm and the greatest width is 0·28–0·63 mm, which occurs invariably at the region of the ventral sucker. The rounded oral sucker is subterminal, 0·18–0·32 mm in diameter, whilst the ventral sucker is considerably larger, situated somewhat posteriorly to the middle of the worm, and is wider than long, being 0·25–0·6 mm across by 0·18–0·44 mm. Transversely across the inside of the ventral sucker runs a low muscular ridge. The oral : ventral sucker width ratio is 1 : 1·08–2·1 and the sucker length ratio is 1 : 0·9–1·6. Only in extended specimens is a prepharynx to be seen, and it reaches to no greater length than 0·04 mm. The small globular pharynx has a diameter of 0·03–0·08 mm and from it leads an oesophagus which varies greatly in length between 0·08–0·22 mm. In grossly contracted specimens it has not been observed. It bifurcates about halfway between the suckers and the caeca are fairly short, terminating dorsally to the testes or vitellaria.

The excretory pore is terminal and leads into a vesicle which reaches forward, dorsally to the uterus, for an undetermined distance and as far as can be seen is a simple tube.

Approximately on a level with the intestinal bifurcation, in a submarginal position, lies the genital pore. The cirrus-sac reaches past the anterior margin of the ventral sucker, and in contracted specimens nearly reaches to the transverse ridge, measuring 0·2–0·37 mm × 0·06–0·09 mm. It contains a coiled seminal vesicle, the coils of which are often tightly packed, a well-developed pars prostatica invested with a mass of gland cells and a cirrus, of about one-third the length of the cirrus-sac. The proximal half of the cirrus appears to be lined with a cuticle which may be thrown in wrinkles. The two oval or elongate oval testes are always partly obscured by the

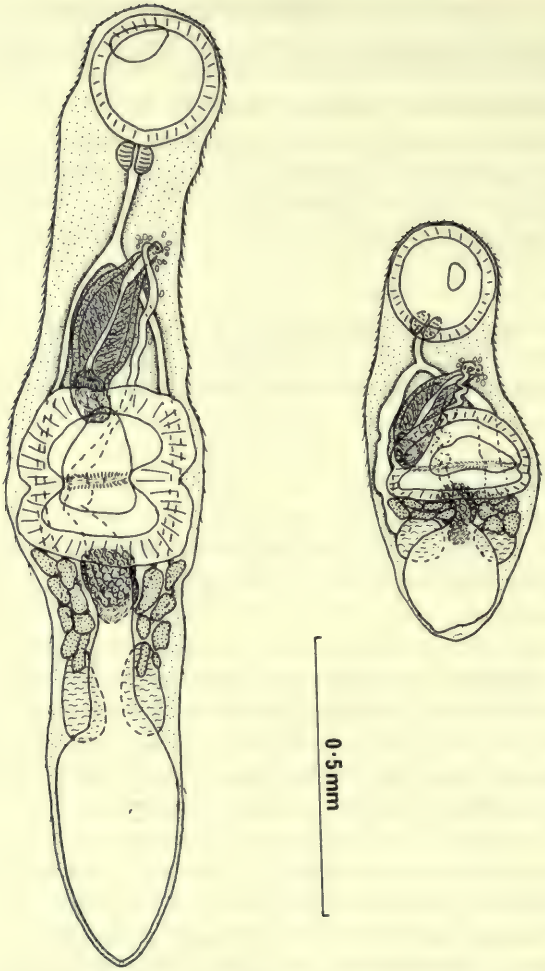

FIG. 7. *Steganoderma abyssorum* (Odhner): two specimens from *Trachyrhynchus trachyrincus* (ventral view).

eggs or the vitelline glands and lie symmetrically one on each side of the body, separated from the posterior border of the ventral sucker by some of the vitellaria. They measure about 0·16–0·22 mm × 0·13–0·2 mm.

The rounded ovary is smaller than the testes, being about 0·15 mm in diameter. It is situated more or less on the posterior border of the ventral sucker, but sometimes entirely posterior or anterior to it. Posteriorly and dorsally to the ovary lies the rounded or oval seminal receptacle, which is rather smaller than the ovary. Immediately posterior to the ventral sucker, in two symmetrical lateral groups, are the vitellaria, which lie somewhat ventrally to the testes, and overlap them in varying degrees. There are between five and ten follicles in each group. The uterus fills most of the area posterior to the ventral sucker, and therefore in the majority of specimens the details of the reproductive organs are obscured. It contains numerous operculate eggs measuring 34–41 μm long by 16–21 μm. The metraterm is long, muscular and helical. It enters a small, muscular genital atrium, which is surrounded by a scattering of glandular cells.

This species was originally described as the type-species of the genus *Proctophantastes* Odhner, 1911, from *Macrurus* (*Coryphaenoides*) *rupestris* and *Gadus aeglefinus* from Norway. Price (1934) considered *Proctophantastes* to be a synonym of *Deretrema* Linton, 1910, but this synonymy was questioned by Manter (1947) who considered it a synonym of *Steganoderma* Stafford, 1904. Odhner (1911a) does not discuss the relationship of *Proctophantastes* with either of the genera with which it has been synonymized. Whilst Price (1934) makes his synonymy with little comment, Manter (1947) discusses the relationship of the three genera in some detail. As has been mentioned above, the latter author considers *Proctophantastes* to be a synonym of *Steganoderma* and he suggests that the differences between the type-species of *Steganoderma*, *S. formosum* Stafford, 1904, and *P. abyssorum* are of specific rather than generic value. These differences are in sucker-size, oesophagus-length and length of vitelline fields. The present author agrees with Manter's conclusion. Therefore, the differences Manter (1947) indicates between *Steganoderma* and *Deretrema* also apply to *Proctophantastes* when compared with *Deretrema*. In short, Price's synonymy is rejected, because the vitellaria in *Deretrema* do not reach posteriorly to the ventral sucker, whilst in *Steganoderma* and *Proctophantastes* the majority of the vitellaria are situated in this region. Subsequent to Manter (1947), only Yamaguti (1953, 1958, 1970, 1971) has continued to consider *Proctophantastes* a valid genus. The features he uses to distinguish *Proctophantastes* from *Steganoderma* are, I believe, not sufficient to uphold the genus. In 1953 he indicates that in *Proctophantastes* the vitellaria are compact, while in *Steganoderma* they are in longitudinally elongate groups. This type of difference would appear to be of specific rather than generic importance, as it concerns fairly small details of the vitelline extent. Yamaguti (1958) distinguishes the genera on the shape of the cirrus-sac and the position of the ventral sucker. An examination of Miller's (1941) redescription of Stafford's specimen of *S. formosum*, and also of the other descriptions of this species given by Manter (1925, 1926), Linton (1940), Ching (1960), Ronald (1960) and Strelkov (1960) shows that the cirrus-sac of this species resembles that of *P. abyssorum* in shape. The ventral sucker in this latter species lies just behind the middle of the body, while in *S. formosum* it lies just anterior to the centre of the body. This condition probably varies with the contraction or growth of the specimen, so that its value as a generic character is rather doubtful. In 1970, Yamaguti suggested that a 'profusely developed "periatrial gland" may be a generic, not a specific character, though not mentioned by Odhner'. He is referring to a character present in a new species he is describing, and this character is, I believe, a feature of *Neosteganoderma*, and is discussed in connection with the following species. The few scattered gland-cells around the genital atrium in the present specimen do not, it appears, represent a feature of generic importance, and, moreover, similar glands have been described in other species of *Steganoderma*, e.g. *S. elongatum* Manter, 1947.

Finally, Yamaguti (1971) upholds *Proctophantastes* on account of the characteristic structure of the genital atrium. There is, however, no peculiar feature in the genital atrium of the present specimens, nor is it indicated in Odhner's generic definition where he merely says 'Genitalsinus ziemlich klein'. As the various attempts to validate *Proctophantastes* do not appear convincing, this genus is here considered to be a synonym of *Steganoderma*.

The present specimens show no outstanding morphological differences from *P. abyssorum*, as described by Odhner (1911a), and are therefore considered to belong to this species. There are, however, two minor differences, the first being the sparse gland-cells around the genital atrium and the second the presence of a ridge running transversely across the inner surface of the ventral sucker. This latter feature was not easy to detect in many whole mounts and may easily have been overlooked by Odhner.

### ***Neosteganoderma glandulosum*** Byrd, 1964, emend

(Fig. 8)

*Proctophantastes glandulosa*: Yamaguti, 1971.

Host and locality: intestine of *Beryx decadactylus*, Stn. 37.

All the worms are contracted to a broadly pyriform shape, which tapers towards the anterior end. The length varies between 1 mm and 1·38 mm and the maximum width, which occurs at the level of the testes, between 0·76 mm and 0·96 mm. Anteriorly, the cuticle bears long, narrow spines which also occur near the posterior extremity. The subterminal oral sucker is rounded, 0·27–0·38 mm across by 0·26–0·33 mm long. At about the middle of the worm, or just behind, lies the transversely elongate ventral sucker, measuring 0·69–0·77 mm across by 0·27–0·33 mm long, reaching close to the lateral margins of the body on either side. The oral : ventral sucker width ratio is 1 : 2·1–2·8, whilst the length of both suckers is almost the same. A small prepharynx can be seen in serial section. It enters a globular pharynx of about 0·11–0·13 mm diameter. The oesophagus is fairly short, curved dorsally to the pharynx, and bifurcates just posteriorly to the pharynx. The caeca are quite short, reaching to a position dorsal to the testes.

The excretory pore is terminally situated, or, when the worm is greatly distended with eggs, it may appear to be slightly dorsal. The saccular vesicle reaches as far as the posterior border of the ovary, and in this region part of it lies ventrally to the seminal receptacle.

On the left side of the body, submarginally and just anterior to the ventral sucker lies the genital pore. The genital atrium has a strong muscular wall, with irregular outpocketings. Into it leads a large cirrus-sac, the bulk of which lies just anterior to the ventral sucker and at right angles to the long axis of the worm. The cirrus-sac reaches transversely across the body to the right intestinal caecum, where it twists and runs slightly posteriorly towards the centre of the ventral sucker, in a plane dorsal to the remainder of the cirrus-sac. The relatively small, coiled internal seminal

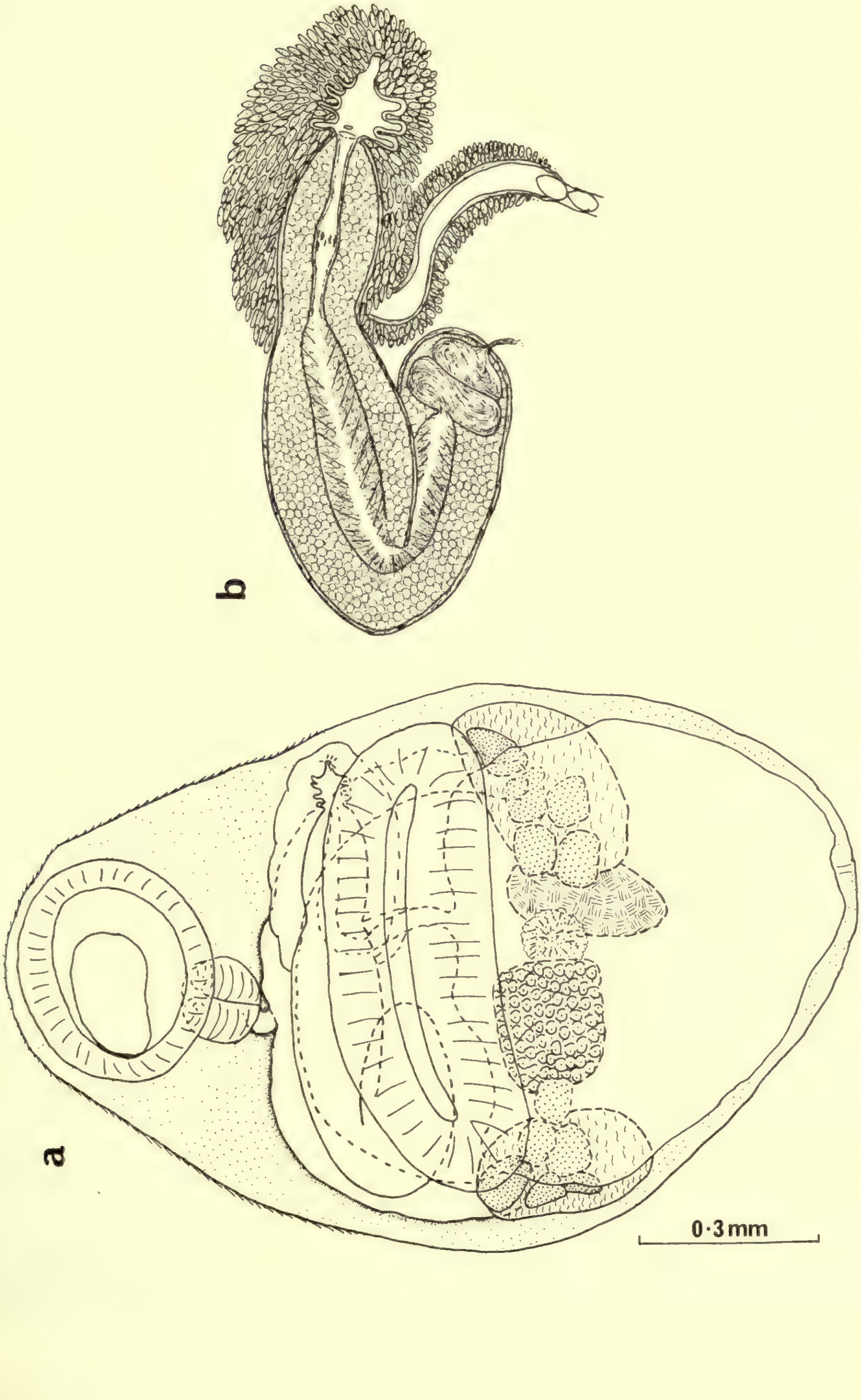

Fig. 8. *Neosteganoderma glandulosum* Byrd: a) ventral view omitting details of terminal genital apparatus; b) terminal genital apparatus (diagrammatic).

vesicle leads into a well-developed pars prostatica, which, with its innumerable associated glands, fills most of the cirrus-sac. The muscular cirrus is shorter, containing some long, narrow spines, lying lengthwise, but as they have been seen clearly only in serial section the overall shape of these spines has not been made out. The testes are arranged symmetrically, just posterior to the ventral sucker and close to the lateral margins of the worm. Apparently, normally they are of an oval shape, but with growth of the uterus certain lobe-like processes appear. In one specimen the testes measured 0·27 × 0·3 mm and 0·4 × 0·19 mm.

Between the testes, and lying towards the right of the worm, is the ovary. In one specimen it was seen to be of an irregular quadrilateral shape, 0·27 × 0·27 mm. The large, oval receptaculum seminis lies dorsally to the ovary and the left testis. It may measure 0·3 × 0·19 mm. Ventral to the anterior extremity of the receptaculum seminis is a well-developed 'shell'-gland. The vitelline follicles are situated in two lateral fields, ventrally to the testes and reaching to about the posterior margin of the ventral sucker. Each field contains four to eight follicles. The egg-filled uterus occupies the great majority of the hindbody, obscuring the reproductive organs in this region. The metraterm is long and, particularly near the genital atrium, strongly muscular. It enters the latter from the dorsal side. For most of its length it is surrounded by an investment of gland-cells (Fig. 8b). Where the metraterm and the cirrus-sac run adjacent to each other the cells invest both organs and also surround the genital atrium. The operculate eggs measure 26–31 μm × 16–21 μm.

Byrd (1964) described *Neosteganoderma glandulosum* from a beryciform fish, *Polymixia lowei*, in the Straits of Florida. He differentiated his new genus from other zoogonids with follicular vitellaria situated posteriorly to the ventral sucker by a number of features. These included the posterior position of the ventral sucker and the elongate oesophagus and forebody, but as can be seen from the present contracted specimens these are not reliable features. It should be noted that Byrd's specimens were treated with chloretone in sea-water before fixation, which probably accounted for the relaxation of the forebody. The other distinguishing characteristics he mentions are the very large ventral sucker and the 'large glandular mass surrounding the genital pore'. The latter feature is very prominent in the present specimens and appears to be the most reliable feature for distinguishing *Neosteganoderma* from the closely-related genus *Steganoderma*. Yamaguti (1971), however, places Byrd's species in *Proctophantastes*, which, as pointed out above, does not possess a large mass of gland-cells surrounding the genital atrium. It appears that Yamaguti is basing his definition of *Proctophantastes* Odhner, 1911, not on its type-species, *P. abyssorum* Odhner, 1911, but on his own species *P. polymixiae* Yamaguti, 1970, from *Polymixia japonica* in the Pacific Ocean off Hawaii, which he describes as having a large 'periatrial gland'. This suggests that this species should become *Neosteganoderma polymixiae* (Yamaguti, 1970) n. comb. It seems possible that it may be found to be conspecific with *N. glandulosum*.

As stated above, certain features of the morphology of the present specimens are different from those described by Byrd, but these are considered to be due to the differences in the fixation technique used. The oesophagus in the present forms is particularly reduced by comparison with the original description. Byrd's statement that the metraterm enters the genital atrium from the ventral side appears to be a typographical error, as a close examination of his figures shows that in his specimens, as in mine, the metraterm enters the genital atrium from the dorsal side.

## Family **FELLODISTOMIDAE** Nicoll, 1913

### (?) ***Steringotrema divergens*** (Rud, 1809) Odhner, 1911

(Fig. 9)

*Distoma divergens* Rud., 1809.
*Fasciola divergens* : de Blainville, 1820.

Host and locality : intestine of *Capros aper*, Stn. 38, Stn. 53.

Seven specimens were recovered from a fish at Stn. 38 and two from a fish at Stn. 53. These specimens are, unfortunately, rather contracted, but enough detail has been observed to suggest that they probably belong to *Steringotrema divergens*.

The worms are oval, often tapering at each end, and measure 0·75–1·2 mm long by 0·42–0·47 mm in maximum width at the level of the ventral sucker. The cuticle is unarmed. The subterminal oral sucker is 0·11–0·15 mm in diameter and leads into a globular pharynx of 0·09–0·11 mm diameter. Because of the contraction the oesophagus is curved, but it bifurcates just about the level of the genital pore, and the intestinal caeca extend to about the level of the testes. About halfway along the body lies the transversely-elongate ventral sucker, measuring 0·21–0·31 mm × 0·38–0·42 mm, giving an oral : ventral sucker ratio of about 1 : 2·7–3·6. The excretory pore is terminal, and the vesicle is V-shaped, the limbs of which have been traced almost to the ventral sucker in serial sections.

About halfway between the suckers and just to the left of the median line lies the genital pore. The rather stout cirrus-sac, 0·18–0·19 mm long and 0·11–0·13 mm wide, contains a bipartite seminal vesicle leading into an elongate pars prostatica which passes from the anterior end of the seminal vesicle to near the posterior end of the cirrus-sac before turning and running anteriorly to unite with a short, muscular, smooth cirrus. Due to contraction of the body, the testes, the ovary and the egg-filled uterus are pressed closely against the ventral sucker. Thus, as the eggs are opaque, the testes and the ovary are discernible only in serial section. The testes lie symmetrically at the lateral margins of the body, with the ovary lying close to the right testis. The vitelline follicles are arranged in four groups, two on each side of the worm, one group anterior to the ventral sucker and the other group posterior to the sucker. The uterus fills almost the whole of the hindbody of the worm and contains numerous operculate eggs, 46–48 μm × 33–37 μm with shell about 2–3 μm thick.

Any slight morphological differences which can be detected between the above description and those given by Odhner (1911b), Palombi (1931) and Mathias (1934) may probably be explained by the contraction of the present worms. The eggs, as measured when teased from the body as well as *in utero*, are rather wider than those

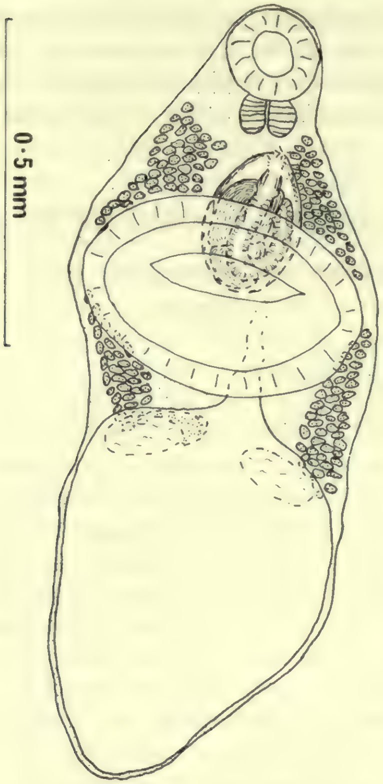

FIG. 9. (?) *Steringotrema divergens* (Rud.) : diagrammatic ventral view with intestine omitted.

previously recorded. A more definite statement on the identity of these specimens awaits better-preserved material. It should be noticed that the previously-reported hosts of *S. divergens* (i.e. gobies and blennies) have a rather different biology from that of the present host.

### ***Steringophorus blackeri*** sp. nov.

(Fig. 10)

Hosts and localities : intestine and body-cavity of *Xenodermichthys copei* (type-host), Stn. 24 ; intestine of *Xenodermichthys* sp. indet., National Institute of Oceanography, Stn. 6429 – 28°07′ N., 13°52′ W. depth 0–390 m.

Four whole specimens were recovered from *X. copei*. One whole specimen and an anterior fragment were found in the body-cavity of the same fish specimen, the fish itself having itself been preserved in formalin. The remainder of the specimens from *X. copei* and the two specimens found in *X.* sp. indet. were taken from the intestine. The worms occurred either singly or in pairs in their hosts. The whole worm from the body-cavity (Fig. 10b) was of a shape and size rather different from

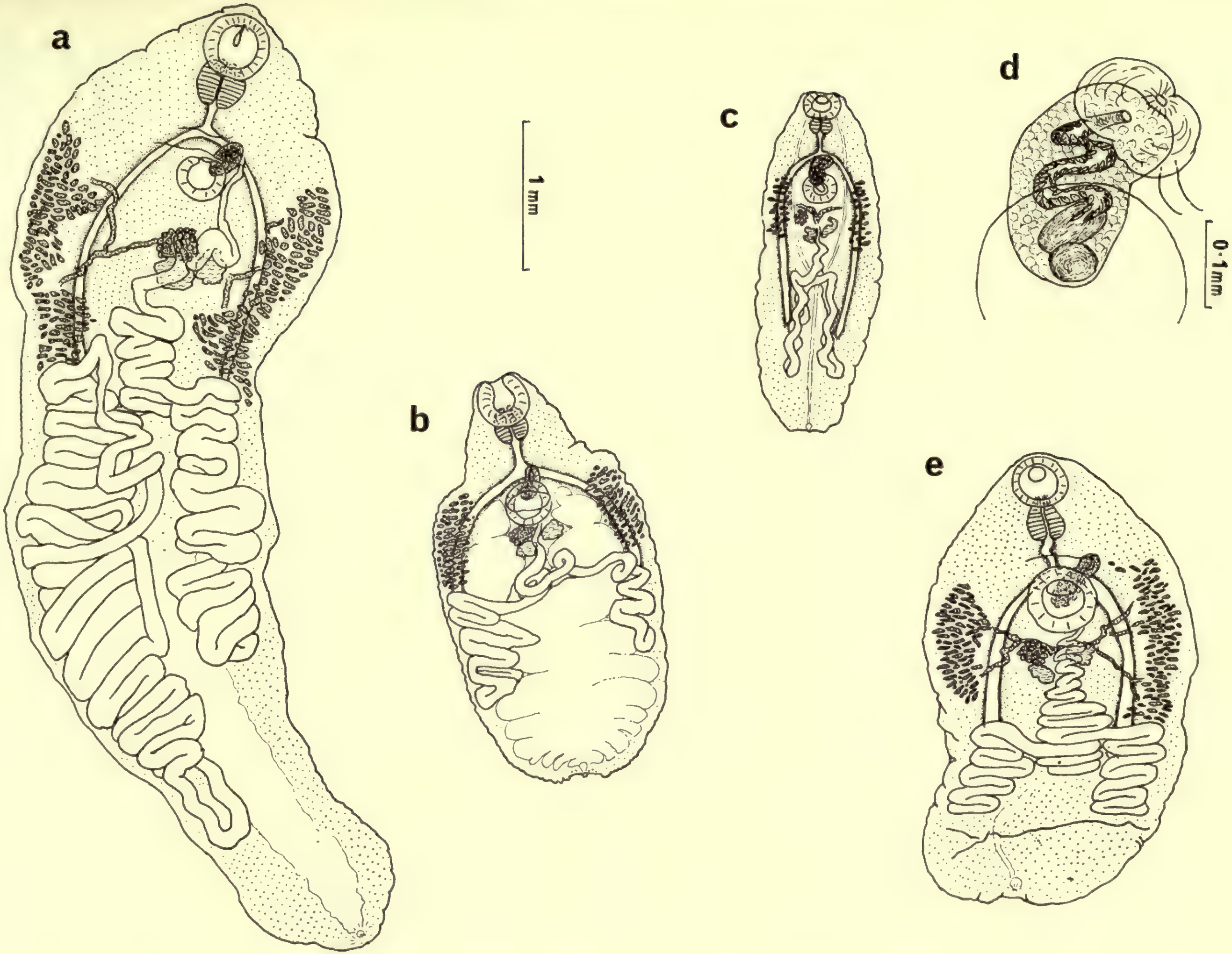

FIG. 10. *Steringophorus blackeri* sp. nov.: a) intestinal form from *Xenodermichthys copei* (ventral view); b) body-cavity form from *X. copei* (ventral view); c) young intestinal form from *X.* sp. indet. (ventral view); d) cirrus-sac and genital atrium of c; e) intestinal form from *X.* sp. indet. (ventral view).

those in the intestine (Fig. 10a), two of which were sectioned for further study. The other specimens, collected by the author from fishes in the collection of the National Institute of Oceanography, included one which was apparently young (Fig. 10c) and an older worm (Fig. 10e). Despite the variation in size, the internal morphology indicates clearly that all these specimens represent the same species.

The 'intestinal form' from *X. copei* is elongate, being widest just posteriorly to the ventral sucker, which is about one-fifth of the body-length from the anterior end. The forebody tapers sharply, while the tapering of the hindbody is less pronounced, and it is rounded terminally. The forms from *X.* sp. indet are much smaller, but with a similarly shaped forebody, and are widest just posteriorly to the ventral sucker (at about one-third of the body-length from the anterior end), the hindbody having slightly tapering lateral margins and a rather truncate posterior end. The 'body-cavity form' from *X. copei* has a similar forebody to the other forms, but the hindbody is considerably swollen by the large bulbous excretory vesicle, the limbs of which reach into the forebody, but do not appear to be swollen in the same way.

The dimensions of the various forms are included in Table 2.

TABLE 2

Measurements of *Steringophorus blackeri* sp. nov.

| Host | *X. copei* | *X. copei* | *X.* sp. indet. | *X.* sp. indet. |
|---|---|---|---|---|
| 'Form' | Intestinal | Body-cavity | Younger | Older |
| No. of specimens | 3 (2 sectioned) | 1 + fragment | 1 | 1 |
| Length (mm) | 4·6–9 | 2·7 | 2·2 | 3·08 |
| Width (mm) | 2·03–2·04 | 1·45 | 0·8 | 1·68 |
| Oral sucker diameter (mm) | 0·47 | 0·34–0·35 | 0·243 | 0·4 |
| Ventral sucker diameter (mm) | 0·43 | 0·29–0·33 | 0·240 | 0·45 |
| Oral : ventral sucker ratio | 1 : 0·92 | 1 : 0·85–0·94 | 1 : 0·98 | 1 : 1·12 |
| Pharynx (mm) | 0·32 × 0·26 | 0·22–0·26 × 0·21–0·19 | 0·125 × 0·11 | 0·21 × 0·25 |
| Oesophagus (mm) | 0·13–0·23 | 0·14 | 0·105 | 0·16 |
| Cirrus-sac (mm) | about 0·32–0·35 × 0·19 | about 0·21–0·32 × 0·12 | 0·26 × 0·14 | 0·48 × 0·16 |
| Ovary (mm) | 0·27 dia. | 0·21 × 0·16 | 0·18 × 0·11 | 0·21 × 0·19 |
| Testes (mm) | about 0·21 × 0·18 | 0·11–0·12 × 0·16 | 0·07 – 0·13 × 0·14 | 0·13–0·14 × 0·17–0·2 |
| Eggs (μm) | 57–63 × 32–34 | 52–58 × 27–30 | 54 × 27–30 | 54–57 × 28–30 |

The cuticle bears no spines, but has numerous transverse wrinkles. The oral and ventral suckers are rounded, and with one exception the oral is slightly larger than the ventral. In some specimens from *X. copei* contraction has caused the opening of the ventral sucker to be disposed anteriorly. There is no prepharynx, so the almost globular pharynx abuts directly with the oral sucker. It leads into a fairly short oesophagus, which bifurcates at about the level of the anterior margin of the ventral sucker, or slightly further forward. The intestinal caeca are lined with a glandular epithelium and run posteriorly to a point normally amidst the uterine coils where they terminate, about halfway along the hindbody.

The excretory pore is terminal and leads into a very small globular vesicle (of about 0·03–0·06 mm in diameter) before entering the main Y-shaped vesicle. The stem of the vesicle reaches to about the middle of the body, whilst the limbs reach anteriorly to the oral sucker. The stem may be very wide or narrow, but the limbs are constantly narrow. The excretory pore itself appears to be on a short protuberance at the base of a depression and is surrounded by glandular cells.

The genital pore is situated on a level with, or just anterior to, the intestinal bifurcation and slightly to the left of the median line. It leads into a muscular genital atrium. The cirrus-sac overlaps the anterior border of the ventral sucker and contains a relatively small, bipartite seminal vesicle, a long, coiled pars prostatica and a short muscular cirrus. The testes lie posteriorly to the ventral sucker a little obliquely to each other, with the left testis being slightly anterior to the right. They are close to the ovary and to each other, are small by comparison with the body-size and have more or less deeply indented margins. The multilobate ovary lies anteriorly and sometimes slightly obliquely to the right testis. It is associated with a large 'shell'-gland, about the same size as the ovary, lying between it and the left testis. Laurer's canal opens dorsally, level with the 'shell'-gland, and may contain a small amount of spermatozoa in its proximal region. Sperm may also lie in the proximal part of the uterus. The vitellaria consists of numerous globular or short transversely-elongate follicles disposed in two symmetrically placed fields near the lateral margins of the body. These fields reach from about the level of the anterior border of the ventral sucker to a position some distance posterior to the testes. The uterus runs in the median line from the ovary to about the middle of the worm, in a series of lateral coils. It then forms a descending series of loops on each side of the body to about two-thirds of the way along the hindbody before passing anteriorly again as a series of loops. It has not been possible to ascertain whether the uterus passes down one side of the body and then down the other, or whether it divides before passing down both sides. The later coils of the uterus pass forward in the median line ventrally to the descending coils and the gonads. In the specimens with the swollen excretory vesicle the lateral uterine slings are forced to lie close to the margins of the body. Within the uterus lie numerous eggs, many of which are collapsed, but which appear to be operculate, with a brownish-yellow shell. This shell is covered with numerous small bosses giving the surface a granular appearance, which is rather less marked in the young specimen from *X*. sp. indet.

MATERIAL. British Museum (Natural History) Reg. no. 1973.4.9.21–24 (syntypes).

Although some recent authors have followed Yamaguti (1953) in considering *Steringophorus* Odhner, 1905, a synonym of *Fellodistomum* Stafford, 1904, it would seem that there may be one feature differentiating these genera, if the distribution of the vitellaria is taken into consideration. In *Fellodistomum* the vitellaria extend anteriorly well beyond the ventral sucker, whilst in *Steringophorus* they do not. A close examination of material of the type-species of both genera from the type-hosts may well indicate other differences, particularly in the length of the caeca and the configuration of the fully-developed uterus.

This new species would appear to be most closely related to *Steringophorus magnus* Manter, 1934, from an unidentified eel-like fish in 300 fathoms at Tortugas, Florida. It differs, however, in the granular pattern of the egg-shell, in the sucker ratio, in the distribution of the vitellaria and in the configuration of the uterus in the hindbody. The sculpturing on the egg-shell seems to be similar to that described in *Benthotrema plenum* Manter, 1934, and it may be noted that although Manter (1934) originally considered this to be a generic character, later (1954) he described a further species in the genus, *B. richardsoni*, in which the eggs apparently have smooth shells.

## Family **HEMIURIDAE** Lühe, 1901

### ***Hemiurus appendiculatus*** (Rud., 1802) Looss, 1899

Host and locality : stomach of *Alosa fallax*, Stn. 41.

Seven specimens were found. This is a common parasite of shads and has been recorded in *A. fallax* [*A. finta*] in various localities in the Mediterranean and north-eastern Atlantic. Nevertheless, *H. appendiculatus* of de Oliveira Rodrigues *et al.* (1972) recorded from *A. fallax* from the coast of Portugal may not belong to this species, as it has, judging from the authors' figure, a relatively short pars prostatica and an undivided seminal vesicle. The normal condition appears to be that represented by the present specimens, in which the pars prostatica is convoluted posteriorly to the ventral sucker, and in which the anterior part of the bipartite seminal vesicle has a thick muscular wall.

### ***Lecithocladium excisum*** (Rud., 1819) Lühe, 1901

Host and locality : stomach of *Scomber scombrus*, Stn. 44.

### ***Lecithochirium gravidum*** Looss, 1907

Host and locality : stomach of *Conger conger*, Stn. 7.

In their revision of *Lecithochirium* Lühe, 1901, Nasir and Diaz (1971) consider *L. gravidum* to be a synonym of *L. rufoviride* (Rud., 1819). These two species are certainly very similar morphologically and according to Looss (1908) and Guiart (1938) they are distinguishable only by size and sucker ratio. *L. gravidum* is small with an oral : ventral sucker ratio of about 1 : 2 whilst *rufoviride* is larger and has suckers of more or less equal size. The present specimens (six in number) have an oral sucker diameter of 0·24–0·29 mm and a ventral sucker diameter of 0·47–0·52 mm, and therefore a sucker ratio of 1 : 1·8–2·1. In an attempt to discover whether or not the sucker ratio in this group is influenced by allometric growth 60 specimens, assigned to one or other of these species, were measured. These specimens, from the collections of the British Museum (Natural History), were all from *Conger conger* collected at Plymouth and Guernsey. The sucker ratio was then plotted against the body-length as is shown in Fig. 11. As can be seen there are two distinct regions, one representing those specimens with a sucker ratio of more than 1 : 1·7 and the other representing those with a ratio of less than 1 : 1·6. Allometric growth does

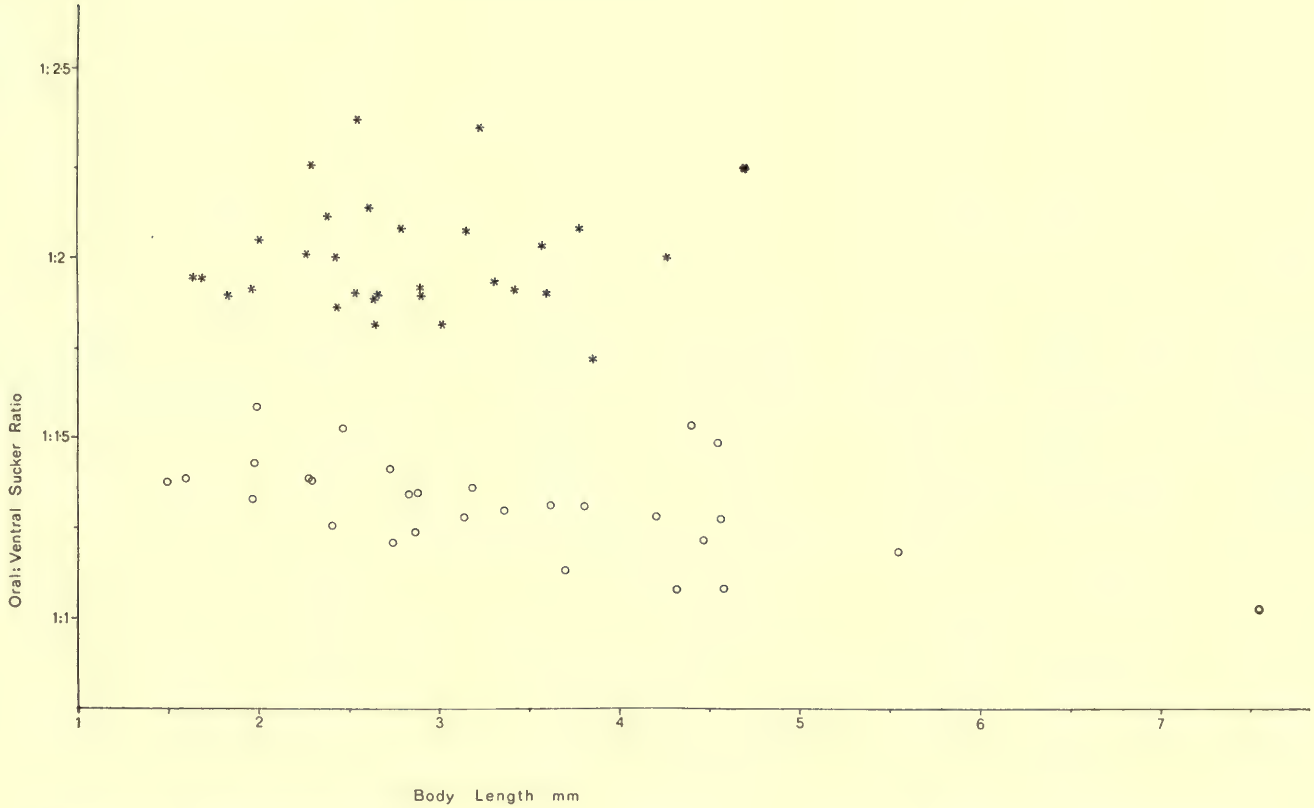

FIG. 11. *Lecithochirium gravidum* Looss and *L. rufoviride* (Rud.) : oral : ventral sucker ratio plotted against body length for 60 specimens (see p. 178).

TABLE 3

Measurements of *Derogenes varicus* from various hosts

| Host | No. of specimens | length (mm) | width (mm) | oral sucker dia. (mm) | ventral sucker dia. (mm) | eggs ($\mu$m) |
|---|---|---|---|---|---|---|
| *Molva macrophthalma* | 1 | 0·95 | 0·31 | 0·14 | 0·28 | 52–54 × 28–29 |
| *Trachyrhynchus trachyrincus* | 2 | 1·18–1·2 | 0·36–0·45 | 0·17–0·2 | 0·32–0·35 | 52–54 × 30–33 |
| *Micromesistius poutassou* | 1 | 0·54 | 0·26 | 0·12 | 0·22 | 53–54 × 33 |
| *Phycis blennoides* | 9 | 0·53–1·04 | 0·32–0·33 | 0·14–0·17 | 0·23–0·25 | 52–57 × 29–33 |
| *Merluccius merluccius* | 19 | 0·53–0·79 | 0·26–0·33 | 0·13–0·16 | 0·23–0·27 | 52–54 × 29–30 |

not appear to have a significant effect on the sucker ratio. It can therefore be seen that, commonly occurring in *Conger conger*, there are two very similar species differing in their sucker ratio, if not in any other obvious feature. This information seems to uphold the validity of the species *L. gravidum*, to which the present specimens are assigned.

### ***Derogenes varicus*** (Müller, 1784) Looss, 1901

Hosts and localities: stomach of *Molva macrophthalma*, Stn. 43; stomach of *Trachyrhynchus trachyrincus*, Stn. 43; stomach of *Micromesistius poutassou*, Stn. 6; stomach of *Phycis blennoides*, Stn. 17; stomach of *Merluccius merluccius*, Stn. 8.

This parasite has been recorded from numerous fishes in polar and temperate waters of the world. This appears, however, to be the first record of this worm from *M. macrophthalma*, *T. trachyrincus* and *M. poutassou*. For this reason a table of important dimensions is given (Table 3).

## ACKNOWLEDGMENTS

My thanks are due to the following: Dr J. P. Harding, late of the British Museum (Natural History), and Dr A. J. Lee of the M.A.F.F. Fisheries Laboratory, Lowestoft, for arranging my participation in the cruise; Mr R. J. Blacker, the naturalist-in-charge, and other M.A.F.F. staff and crew members of 'Cirolana' for their help and advice; Dr N. R. Merrett of the National Institute of Oceanography, Wormley, Surrey, for allowing me to examine fishes in the N.I.O. collection; and Mr A. Wheeler of the British Museum (Natural History) for identifying some of the fish. Finally, I would like to thank Mr S. Prudhoe for his advice and encouragement during this study.

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BRITISH MUSEUM
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NATURAL HISTORY

# OBSERVATIONS ON *TRINEMA LINEARE* PENARD (TESTACEA: PROTOZOA)

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BY

RONALD HENDERSON HEDLEY K

AND

COLIN GERALD OGDEN A/E

*Pp.* 185–199; *7 Plates,* 1 *Text-figure*

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THE BULLETIN OF THE BRITISH MUSEUM (NATURAL HISTORY), *instituted in* 1949, *is issued in five series corresponding to the Departments of the Museum, and an Historical series.*

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*World List* abbreviation :
*Bull. Br. Mus. nat. Hist.* (Zool.)

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TRUSTEES OF
THE BRITISH MUSEUM (NATURAL HISTORY)

*Issued 7 February,* 1974 *Price* £1.50

# OBSERVATIONS ON *TRINEMA LINEARE* PENARD (TESTACEA : PROTOZOA)

*By* R. H. HEDLEY AND C. G. OGDEN

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## SYNOPSIS

*Trinema lineare*, a geographically widespread, fresh-water, moss and soil inhabiting testacean, has been established in clonal culture with a doubling time of between 72 and 78 hours. Full descriptions are given of the siliceous shell and the fine structure of the vegetative stage. Ultrastructural features of special interest include the presence of microbodies, and a microtubule-organizing-centre associated with the nucleus at prophase.

## INTRODUCTION

THE five known species of *Trinema* Dujardin, 1841, are amongst the most widely reported rhizopods to be found in soil, sphagnum moss and fresh-water habitats. Very little is known of their biology and there has been no previous report of the cytoplasmic ultrastructure. The present paper is an account of the fine structure of cultured specimens of *Trinema lineare* Penard, 1890, isolated from a sample of moss and soil from Cliffe Marshes, Rochester, Kent, in February, 1970. It is the second of a series of papers devoted to testate amoebae aimed at providing a fuller understanding of their biology, and a fuller appreciation of the significance and nature of the siliceous shell. The first paper in the series was devoted to a detailed account of *Euglypha rotunda* – a widely distributed species (Hedley and Ogden, 1973).

*Trinema* belongs to the family Euglyphidae and the classification adopted here is that proposed by Loeblich and Tappan (1961) :

| | | |
|---|---|---|
| Class | *RHIZOPODEA* | Von Siebold, 1845 |
| Subclass | *FILOSIA* | Leidy, 1879 |
| Order | GROMIDA | Claparède and Lachmann, 1859 |
| Superfamily | **EUGLYPHACEA** | Loeblich and Tappan, 1961 |

Family **EUGLYPHIDAE** Wallich, 1864;
test hyaline, symmetrical, elongate, composed of rounded siliceous scales, aperture rounded or elongate: one nucleus.

### Previous work – biology

Leidy (1879) examined several testate amoebae from North America and suggested that the cytoplasmic structures of *Trinema* were similar to those in *Euglypha*, in that each had a single nucleus and two contractile vacuoles. Penard (1902) observed that when the animals were inactive, or in the vegetative phase of their life cycle, the granular zone and nucleus appeared to be distinct. Dunkerly (1923) reported that reserve shell-plates were arranged around the nucleus, and suggested that certain dark granules were chromidia. Chardez (1960) noted that the cytoplasm did not fill the shell cavity and that it appeared to be attached only at the apertural collar.

Both Penard (1902) and Leidy (1879) described the pseudopodia as very fine, usually two or three and occasionally six in number. According to Leidy (1879) when the animal moves, the body is inclined so that the aperture faces anterior and down, while the fundus points backwards and up.

During binary fission, Penard (1902) observed that the animals are diametrically opposed whereas at conjugation they appear to be directly apposed. Chardez (1960) observed the part of the reproductive cycle when clear cytoplasm passed into the daughter shell, until the moment that the daughter cell became packed with agitated vacuoles. The cytoplasmic volume attained full size within 20 minutes. Chardez (1960) also reported the formation of a cyst with two nuclei as a phenomenon of conjugation, in which the cytoplasm of the two conjugants become joined in one shell, the empty shell remaining provisionally united. Similar united individuals, with one shell empty and the other containing cytoplasm and two nuclei, were observed by Dunkerly (1923) who considered this to be a stage of encystation, after which the cytoplasm contracted, the chromidia disappeared – at least as staining bodies – and finally the nuclei fused. Dunkerly (1923) also suggested that the chromidia were used up during encystation as reserve food material.

As a result of an ecological study of a Netherland fen, de Graff (1956) reported that *Trinema enchelys* and *T. lineare* show an optimum distribution in moderate dry mosses, but were found in most kinds of biotopes, only *T. lineare* avoiding the drier mosses. In a review of soil protozoa, Stout and Heal (1967) described *T. lineare* as an ubiquitous species, found in both organic and mineral topsoils, and having the same pH tolerance as the common soil ciliates and flagellates. They also stated that most testaceans – with some exceptions including *T. lineare* – reproduce slowly, have poor encystment mechanisms and poor tolerance to high carbon dioxide and low oxygen tensions and salinities.

### Previous work – taxonomy

*T. lineare* was described first by Penard (1890), who considered it to be smaller and more elongate than *T. enchelys* (Ehrenberg, 1838). The same author (Penard,

1902) later redefined the size as being 16–26 μm and rarely 30 μm. Cash *et al.* (1915) redescribed three species of *Trinema*, including *T. lineare*, and one variety in a review of the *British Rhizopoda Fauna*. They listed *T. acinus* Leidy, 1879 as a synonym of *T. lineare*, but this is probably a doubtful species because Leidy (1879) described only *T. enchelys* and figured only *T. acinus*. Both Volz (1929) and Kufferath (1932) suggested that *T. lineare* was a synonym of *T. enchelys*, whereas subsequent authors have recognized both species. Hoogenraad and de Groot (1940) redescribed three species and listed some measurements of previous authors. Chardez (1956) figured numerous variations in the shape and size of the shell of both *T. enchelys* and *T. lineare*.

Thomas (1958) suggested that there are three types of shell: firstly, those with large completely overlapping plates; secondly, those with large incompletely overlapping plates with smaller plates filling the gaps; and thirdly, those with large separate plates with many small plates; the first type is seen fairly often, the second is very common whilst the last type is rare.

Bonnet and Thomas (1960) redescribed five species of *Trinema* and one variety, *T. complanatum* Penard, 1890; *T. complanatum* var. *globulosa* Chardez, 1959; *T. enchelys*; *T. galeata* (Penard, 1890); *T. lineare* and *T. penardi* Thomas and Chardez, 1958, with a list of their recorded distribution. In several publications Decloitre (1961a, b, 1964a, b, 1965a) has provided additional measurements and localities, and discussed variation seen in some testaceans. Decloitre (1962) described a new variety of *T. lineare*, *T. lineare* var. *terricola* having a ventral aperture, and more recently Stepanek (1967) described two varieties, *T. lineare* var. *globulosa* having a mouth at one side and *T. lineare*, var. *pellucida* having an elliptical mouth.

## MATERIALS AND METHODS

*T. lineare* was isolated from a sample of moss and soil collected on Cliffe Marshes, near Rochester, Kent, in February, 1970. Crude cultures were made from small portions of this material placed in the culture liquid and kept in the laboratory at room temperature, 18–20°C. Agnotobiotic cultures were kept, in small plastic containers, on a thin substrate of agar (1 per cent agar agar in distilled water) with a sterilized wheat grain added prior to setting, and covered with a shallow layer of the culture liquid. This liquid was a 5 per cent (w/v) solution of soil extract, plus 100 mg/l$^{-1}$ of sodium nitrate and 15 mg/l$^{-1}$ of sodium dihydrogen orthophosphate, in distilled water.

Clonal cultures were obtained by isolating single, active animals. One such clone was subsequently used to produce working cultures. If sub-cultures are made at intervals of between three or four weeks the animals appear to feed and reproduce readily. The clone which was used to produce working cultures is now deposited at the Culture Centre of Algae and Protozoa, the Natural Environment Research Council, Cambridge, England.

*Optical microscopy* – The animals were examined by bright-field and phase-contrast microscopy, either alive or after fixation. Smears fixed in either Schaudinn's fluid or glutaraldehyde were stained with either borax carmine or iron haematoxylin.

*Scanning electron microscopy* – For morphological studies on external morphology both live animals and empty shells were used. Living specimens were fixed initially in 3 per cent glutaraldehyde in distilled water for 30 minutes. The empty shells were washed initially in several changes of distilled water. Single specimens were then passed through several changes of triple glass distilled water using either a single-hair brush or a fine-bore pipette. They were then manipulated onto a small cover-slip, previously cleaned with acetone and lint-free tissue, and allowed to dry. Dried specimens adhere well to glass but can be moved by use of a moistened single-hair brush. For the examination of individual siliceous plates, single clean specimens were placed on a fragment of cleaned cover-slip, covered with a small drop of concentrated sulphuric acid and gently heated. On evaporation of the acid the plates are liberated from the organic cement. The treated cover-slips were attached to 'Stereoscan' stubs by an electrically-conductive paint, 'Silver Dag', and then coated evenly with 10–15 nm of gold using an Edwards coating-unit with a planetary specimen holder (Harris *et al.*, 1972). The stubs were examined on a Cambridge Stereoscan Mk II at either 15 or 20 kV and the results recorded on Ilford 35 mm HP3 film.

*Transmission electron microscopy* – Animals were fixed at room temperature for 15 minutes in 1 per cent glutaraldyhyde in 0·05 M Sorenson's phosphate buffer plus 0·0015 M calcium chloride, followed by 10 minutes in 3 per cent glutaraldehyde in the same buffer. After several rinses in buffer, they were post-fixed in 1 per cent osmium textroxide in 0·1 M Sorenson's buffer. To facilitate subsequent handling the specimens were occasionally embedded in 1·5 per cent agar at this stage, prior to dehydration. The material was dehydrated by passage through a series of graded water/ethanol mixtures, ending in absolute ethanol and embedded in Epon 812. Sections were cut on a Porter Blum MT2 ultramicrotome using a Du Pont diamond knife, stained with alcoholic uranyl acetate and Reynold's lead citrate, and examined in an A.E.I. 6B electron microscope operating at 60 kV. The results were recorded on Ilford's 'Special Lantern Contrasty' plates.

## DISTRIBUTION

*T. lineare* is commonly found in damp and wet mosses and various soils. A list of localities and references from which it has been recorded is given by Bonnet and Thomas (1960). Additional localities are given here based on records of several authors, namely, Hoogenraad and de Groot (1952a, b), Bonnet (1966), Decloitre (1964a, 1965a, b), Chardez (1961, 1969) and Golemansky (1971).

The following list illustrates the geographically wide distribution of *T. lineare* :

| | |
|---|---|
| EUROPE : | Great Britain, Spitzbergen, Iceland, Finland, France, Belgium, Netherlands, Germany, Italy, Czechoslovakia and Hungary. |
| NORTH AMERICA : | United States of America, Canada and Greenland. |
| SOUTH AMERICA : | Tristan da Cunha, Chile, Bolivia and Peru. |

| | |
|---|---|
| AFRICA : | Angola, Morocco, Congo, French Cameroons, Algiers, Guinea, South Africa and the Seychelles. |
| ASIA : | India, China, Siberia and Japan. |
| AUSTRALASIA : | Australia, New Zealand and Tasmania. |
| ANTARCTICA : | South Georgia and Gough Island. |

## MORPHOLOGY AND VARIATION

The siliceous shell is elliptical in shape through the major axis and circular through the minor axis ; it varies in length between 25 and 34·5 μm and in breadth between 14.5 and 19 μm (Pl. 1, figs. B and E). The aperture is normally circular, invaginated and situated sub-terminally, having a diameter of between 6 and 8·5 μm (Pl. 1, figs. A, B and E). Its position may vary greatly through various angles to the longitudinal axis of the shell, including being terminal. The shell is composed of three different types of siliceous plates : small, circular apertural plates (Pl. 1, figs. C and D), large, circular shell-plates (Pl. 1, fig. B) and small, oval to circular shell-plates (Pl. 1, figs. D and F).

The apertural plates are roughly circular, folded along the median line with a small central dorsal tooth (Pl. 1, figs. C and D), and vary between 1·2 and 1·5 μm in diameter. The number per specimen appears to vary between 18 and 28, but the majority of animals have between 22 and 26. The apertural plates may occasionally be moved from their marginal position either to form double rows or to be displaced out of symmetry. Usually either one or two rows of between 13 and 16, small shell-plates are arranged adjacent to the apertural plates (Pl. 1, fig. A), but these are also subject to some variation, in one instance being replaced by large shell-plates.

The large circular, slightly convex shell-plates have a diameter of between 4·0 and 5·5 μm and a thickness of between 0·12 and 0·20 μm ; whereas the small oval to circular, convex shell-plates (Pl. 1, fig. F) vary in length between 2·4 and 3·5 μm and are between 0·11 and 0·20 μm thick. *T. lineare* has approximately 50 incompletely overlapping large shell-plates with an unknown number of small shell-plates haphazardly filling the interstices, many of them being completely overlaid by the large shell-plates. This is the second and most common of the three types of shell-plate arrangement noted by Thomas (1958). Although the plates are normally arranged evenly, an occasional shell is seen in which some shell-plates are reversed, with the concave surface facing outwards (Pl. 6, fig. E).

The incidence of abnormally shaped shells (Plate 2) is usually less than 1 per cent, although as many as 10 per cent of one culture was observed to have abnormal forms. Cash *et al.* (1915) and Chardez (1970) have illustrated previously the variation in the position of the aperture and included some examples of evaginated apertures. The most frequently seen abnormal forms are a single shell possessing two apertures – an aperture being defined as an opening bordered by apertural plates. Openings in the shell due to inadequate shell-plate coverage are common (Pl. 2, fig. F), and as many as six openings have been seen in one individual. It would appear that the number of shell-plates in abnormal forms is roughly proportional to the number of apertures.

There is also a slight increase in the amount of organic cement binding the plates of the abnormal forms.

There appear to have been only two previous reports concerning the surface ultrastructure of *T. lineare*, both of which are based on carbon and metal-shadowed preparations. Thomas and Hovasse (1962) described two types of plates, large and small, with the aperture bordered by a collar of biconvex spines. Mercier *et al.* (1964) described the aperture as being surrounded by one or two circles of small spiny plates.

## REPRODUCTION

An estimate of the doubling time was obtained by growing three replicate cultures, and recording the number of animals present at regular intervals. Growth curves produced from these results show that the doubling time is between 3·0 and 3·4 days. A similar calculation for *Euglypha rotunda* gave a doubling time of between 1·4 and 1·9 days (Hedley and Ogden, 1973).

Binary fission is completed in approximately 60 minutes. The initial stages are difficult to observe in *T. lineare* due to the small size of the animal and the oblique position of the aperture. Cytoplasmic division, once the daughter shell has been formed, proceeds in a manner similar to that previously described (Hedley and Ogden, 1973) for *E. rotunda*.

## ULTRASTRUCTURE OF VEGETATIVE STAGE

The cytoplasm does not quite fill the shell cavity (Pl. 3, fig. A), but appears to be anchored to the apertural collar. Numerous fine processes can be seen extending between the cytoplasm and the inner shell wall (Pl. 3, fig. A). Unevenly spaced pellicular microtubules lie beneath the plasmalemma and run in an antero-posterior direction. The mitochondria are ovoid or spherical in shape, possess tubular cristae, and appear to be distributed at random throughout the cytoplasm.

*Nucleus.* The vegetative or interphase nucleus is usually spherical, between 4·4 and 5·7 μm in diameter, occupying a central position at the posterior end of the cytoplasm (Pl. 3, figs. A and D). It is bound by a nuclear envelope made up of two tripartite membranes, the outer membrane being continuous with the granular endoplasmic reticulum. The nuclear matrix is finely granular, with small concentrations of densely-staining chromatin scattered throughout and a dense nucleolus.

Although the nucleus during interphase was spherical in most animals examined, a number have been observed which are cone-shaped posteriorly (Pl. 4, fig. A), and it is assumed that this is correlated with the early stages of prophase. The cone-shape is caused by the convergence of numerous microtubules towards a specific region at the posterior end of the cytoplasm. The microtubules are first seen converging on the nucleus around its equatorial region (Text-fig. 1 ; Pl. 6, fig. A), whilst at a level in the region of the contractile vacuoles they lie in the endoplasmic reticulum at some distance from the nucleus. Although it is difficult to estimate the number of microtubules present because of the close relationship of the dense endoplasmic reticulum, it is apparent that the numbers increase to approximately 70 in the posterior region of the cytoplasm.

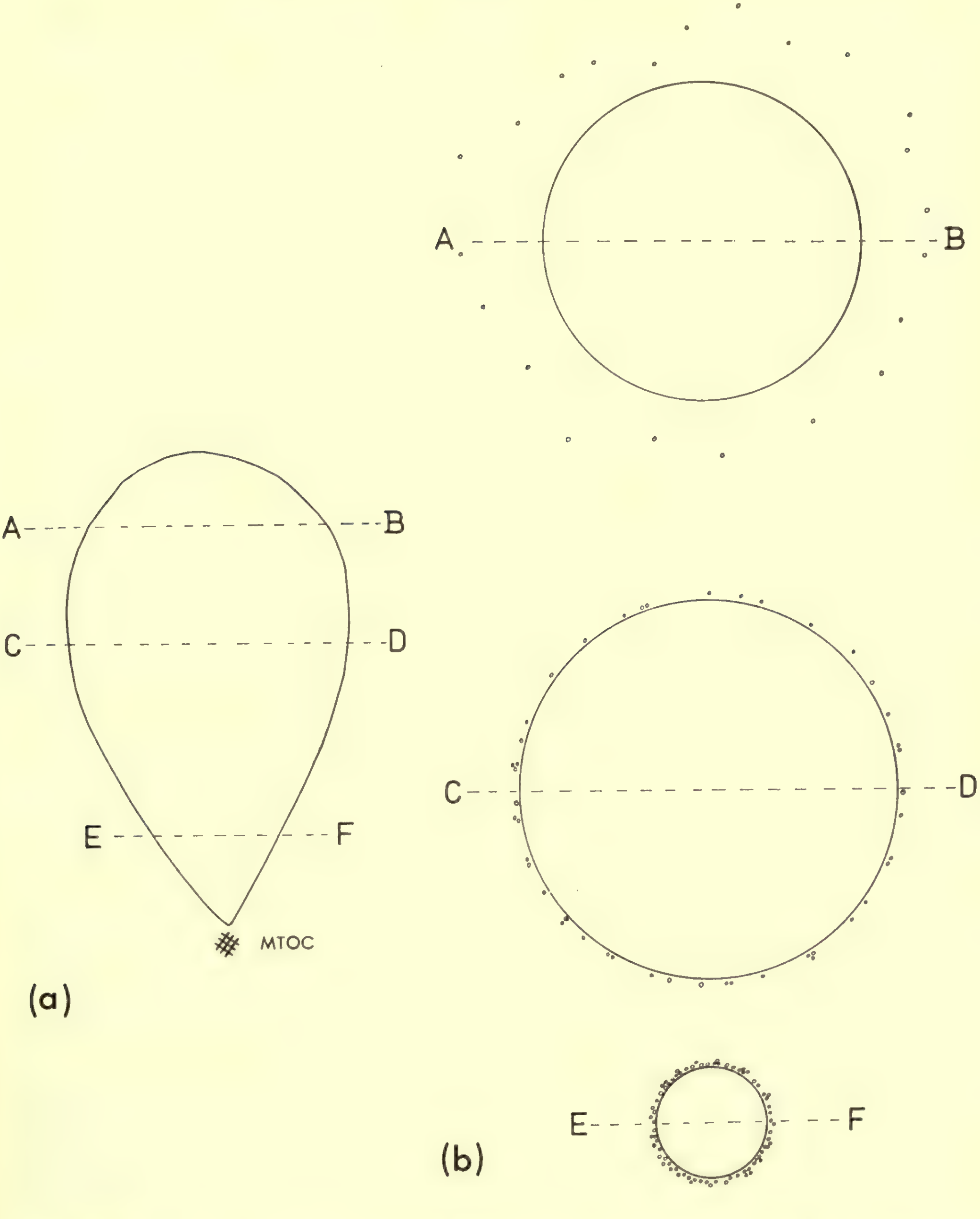

FIG. 1. (a) Diagram of a longitudinal section through the nucleus (see Pl. 4, fig. A). (b) Tranverse sections at those levels of the nucleus marked A-B, C-D and E-F in (a), to illustrate the microtubules converging towards the microtubule-organizing-centre (MTOC), as discussed in the text.

The microtubules lie close to the nuclear membrane (Pl. 4, fig. C), but do not lie in invaginations similar to those reported by Leadbeater and Dodge (1967) for the dinoflagellate *Woloszynskia micra*. They appear to attach to an electron-dense area close to the distal end of the nucleus (Pl. 4, figs. C and D), which is comparable with previously described and similar regions in the alga, *Chara* (Pickett-Heaps, 1968), fungal zoospores (Fuller and Calhoun, 1968), the soil amoeba, *Acanthamoeba castellanii* (Bowers and Korn, 1968), the marine amoebae, *Stereomyxa ramosa* and *S. angulosa* (Benwitz and Grell, 1971a, b), and the marine protist, *Labyrinthula* (Perkins, 1970). Such regions of attachment for microtubules are referred to in other cells under a variety of terms. For example, in dividing plant cells, Pickett-Heaps (1969) referred to it as a 'microtubule-organizing-centre' – MTOC, and suggested that such centres initiate and control the arrangement of microtubules. An MTOC was also described by McCully and Robinow (1972) in association with the nucleus during mitosis in yeasts. In *Labyrinthula*, Perkins (1970) described the granular aggregate as a 'protocentriole', while the term 'paracentrosome' was suggested by Manton *et al.* (1970) for the precursor material seen to accumulate near each pole at meiotic division in the marine centric diatom, *Lithodesium undulatum*. Fuller and Calhoun (1968) stated that the kinetosome of fungal zoospores is an unlikely 'organizing centre' but suggested that the electron-opaque material surrounding the proximal third of the kinetosome could be such a 'centre'. In mouse oocytes electron-dense fibrillar areas, close to the nucleus, from which microtubules radiate are referred to by Szollosi *et al.* (1972) as 'microtubule foci'. Evidence that such regions indicate the site of microtubule formation in many systems has been provided by Tilney and Goddard (1970) and Tilney (1971), who conducted experiments on the breakdown and reformation of microtubules in certain species of Heliozoa.

*Contractile vacuoles.* Two or three contractile vacuoles occur at the edge of the granular endoplasmic reticulum (Pl. 3, fig. D) in the region of the nucleus. These vacuoles are often surrounded by numerous vesicles which are associated with the lumen of the vacuole, and they discharge directly into the shell cavity.

*Microbodies.* Microbodies appear in all the specimens examined (Pl. 3, fig. B). They are ovoid or spherical in shape, varying in size between 0·30 and 0·55 $\mu$m, with a dense granular matrix surrounded by a single unit membrane. Tubular elements, between 18 and 26 nm in diameter, appear within the matrix (Pl. 4, fig. E), and as many as four tubules are apparent as cross-sections or loops in some microbodies.

The microbodies in *T. lineare* are similar to those reported in various Foraminifera by Hedley *et al.* (1967), Hedley and Wakefield (1969) and Febvre-Chevalier (1971), in possessing tubular-like elements within the matrix. Hedley and Wakefield (1969) imply that such organelles are possibly a normal component of the cytoplasm of the Foraminifera. The structure and function of microbodies has been reviewed recently by Hruban and Rechcigl (1969).

*Endoplasmic reticulum.* A concentrated mass of granular endoplasmic reticulum usually surrounds the nucleus, and appears more electron-dense than the surrounding cytoplasm due to the concentration of ribosomes (Pl. 3, figs. A and D). In early prophase, however, the nucleus is drawn out distally from the endoplasmic reticulum region (Pl. 4, fig. A).

*Pigment zone.* A zone of large vacuoles lies immediately anterior to the endoplasmic reticulum region (Pl. 3, fig. A). They contain electron-dense material and have previously been equated by Hedley and Ogden (1973) to the 'pigment zone' of earlier light microscopy workers. A probable developmental sequence in the formation of the electron-dense material in the vacuoles is illustrated in Pl. 3, figs. A and B – the various stages are labelled 1 to 4. The initial stage (1) shows the matrix to be granular with a small electron-dense area in the centre. As this deeply stained area increases in size (2 and 3) the matrix becomes coarser and uneven rents appear in the electron-dense material. In the final stage (4) the vacuole is composed mainly of electron-dense material. The rents in the electron-dense material are possibly caused by its impermeability to the embedding resin. No explanation can be made at present regarding the occurrence of this constant structure, or of the occasional empty vacuoles seen here and reported previously by Hedley and Ogden (1973) for *Euglypha rotunda.*

*Golgi apparatus.* A single Golgi apparatus lies immediately posterior to the nucleus at the edge of the endoplasmic reticulum region (Pl. 4, fig. A). Both smooth and coated vesicles are associated with the Golgi saccules (Pl. 4, fig. B). In addition, the saccules of the Golgi are often distended by small concentrations of densely staining fibrillar material (Pl. 5, fig. C). These concentrations appearing in the outer saccules of the dictyosome become progressively spherical as the concentration of material increases and finally are detached at the margins of the saccules as membrane-bound vesicles. At this stage the fibrillar material is concentrated mainly at the centre of the vesicle, and has small strands radiating from the centre (Pl. 3, fig. C). The vesicles then pass around the outside of the endoplasmic reticulum region and are distributed randomly throughout the cytoplasm.

It has already been established (Favard, 1969) that the Golgi apparatus appears to play a role in the packing of secretory products for export and storage. The chemical constituents of such secretory products in both plants and animals are usually polysaccharide or protein macromolecules. Hedley and Wakefield (1969) suggested that the polysaccharide produced by the Golgi apparatus of the marine protozoon, *Gromia oviformis,* appeared to be used in the formation of the proteinaceous shell-wall. Schwab (1969) also suggested that the fibrillar shell-wall material in the marine foraminifera, *Myxotheca arenilega,* is produced by the Golgi apparatus. More recently, Hedley and Ogden (1973) have suggested that the fine fibrillar, polysaccharide material contained in the spherical, membrane-bound vesicles of *E. rotunda* might be utilized to form the proteinaceous cement or glue, that lines the inside of the siliceous shell and also binds the shell-plates of this testate amoeba.

It seems reasonable to suggest that the fibrillar vesicles (Pl. 3, fig. C) produced by the Golgi apparatus in *T. lineare* might be the initial stages in the formation of the organic cement bodies (Pl. 5, fig. E).

Another type of vesicle, with a double unit membrane and usually electron-transparent contents, often occurs lying in the area of cytoplasm between the distal end of the granular endoplasmic reticulum region and the Golgi apparatus (Pl. 5, fig. D). Occasionally they occur in the cytoplasm anterior to the granular endoplasmic reticulum region, surrounded by a ring of smooth endoplasmic reticulum (Pl. 5, fig. A). The function of these vesicles is at present unknown.

*Food particles.* Food particles, which are usually gram-negative bacteria, occur throughout the cytoplasm, whereas in *E. rotunda* they are confined to the anterior third of the cytoplasm (Hedley and Ogden, 1973). Nevertheless, digestion in *T. lineare* probably occurs in the enlarged food vacuoles which are found normally in the anterior cytoplasm.

*Reserve shell-plates.* Reserve shell-plates are formed in that region of granular endoplasmic reticulum that surrounds the nucleus and close to the Golgi apparatus. As the shell-plates are formed they become closely packed together in a region just anterior to the nucleus (Pl. 6, fig. D). Both large and small shell-plates appear to be formed at the same time. The apertural plates appear to be the last to be formed and are usually seen only in the posterior region of the cytoplasm, with their dorsal teeth pointing outwards.

Large inclusions, containing electron-dense material, are present in the granular endoplasmic reticulum region (Pl. 3, fig. A). These inclusions appear to be less dense than the 'pigment zone' vacuoles and are often seen to fuse with the unit membrane of reserve shell-plates (Pl. 6, fig. B). It seems probable that these inclusions are associated with the formation of the siliceous plates as they are frequently seen in specimens containing reserve shell-plates. It is noted, however, that whereas in sections of animals fixed and subsequently treated in the absence of heavy metals the siliceous plates are naturally electron-dense (Pl. 7, fig. A), the inclusions in the endoplasmic reticulum are electron-transparent.

The only additional reference to those previously reported by Hedley and Ogden (1973) regarding the formation of siliceous material is that of Cachon and Cachon (1971) on silica metabolism in Radiolaria. They suggest that the siliceous shells of digested micro-organisms, upon which radiolarians feed, are used to produce their siliceous skeletons, and the unused siliceous material is rejected in gel form.

*Organic cement.* The organic cement or glue that holds the plates together is a fine fibrillar material probably produced by the Golgi apparatus. It is circulated within the cytoplasm in membrane-bound vesicles (Pl. 5, fig. E), and is discharged mainly in the anterior region where the vesicles fuse with the plasmalemma. In abnormal forms there is usually more cement at shell-plate junctions than in normal specimens.

*Pseudopodia.* The fine structure of the pseudopodia consists of ground plasm limited by a membrane, and occasionally containing microfilaments. Our observations are, however, limited to cytoplasmically joined individuals, in which microtubules are often seen in the cytoplasm internal to the aperture, but not externally (Pl. 6, fig. C). Similar observations on microtubules were reported for *Difflugiella* sp. by Griffin (1972) and for *E. rotunda* by Hedley and Ogden (1973).

*Rosette groups.* Rosette-like groups are frequently seen in clonal cultures which are four or five weeks old (Pl. 2, fig. G and Pl. 7, figs. C–E). The groups are usually composed of five individuals or less and are joined by cytoplasmic connections. These connections contain numerous cement bodies and less frequently mitochondria (Pl. 7, fig. C). In contrast to the situation reported by Hedley and Ogden (1973), for similar formations in *E. rotunda*, microfilaments are seldom present. Individuals with reserve shell-plates are seldom seen in rosette groups, suggesting that such formations may be the result of starvation.

### Abnormal forms

The cytoplasm of animals with abnormal shapes (Pl. 2) is similar to that of normal animals with the exception that the number of nuclei appears to be related to the number of apertures (Pl. 7, fig. F). From our observations all attempts by these forms to divide are abortive.

## ACKNOWLEDGEMENT

We would like to acknowledge the technical assistance of Mrs J. E. Dorahy.

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## PLATE 1

A. Aperture of *T. lineare* ; note the invagination produced by the curved shell-plates. × 7100

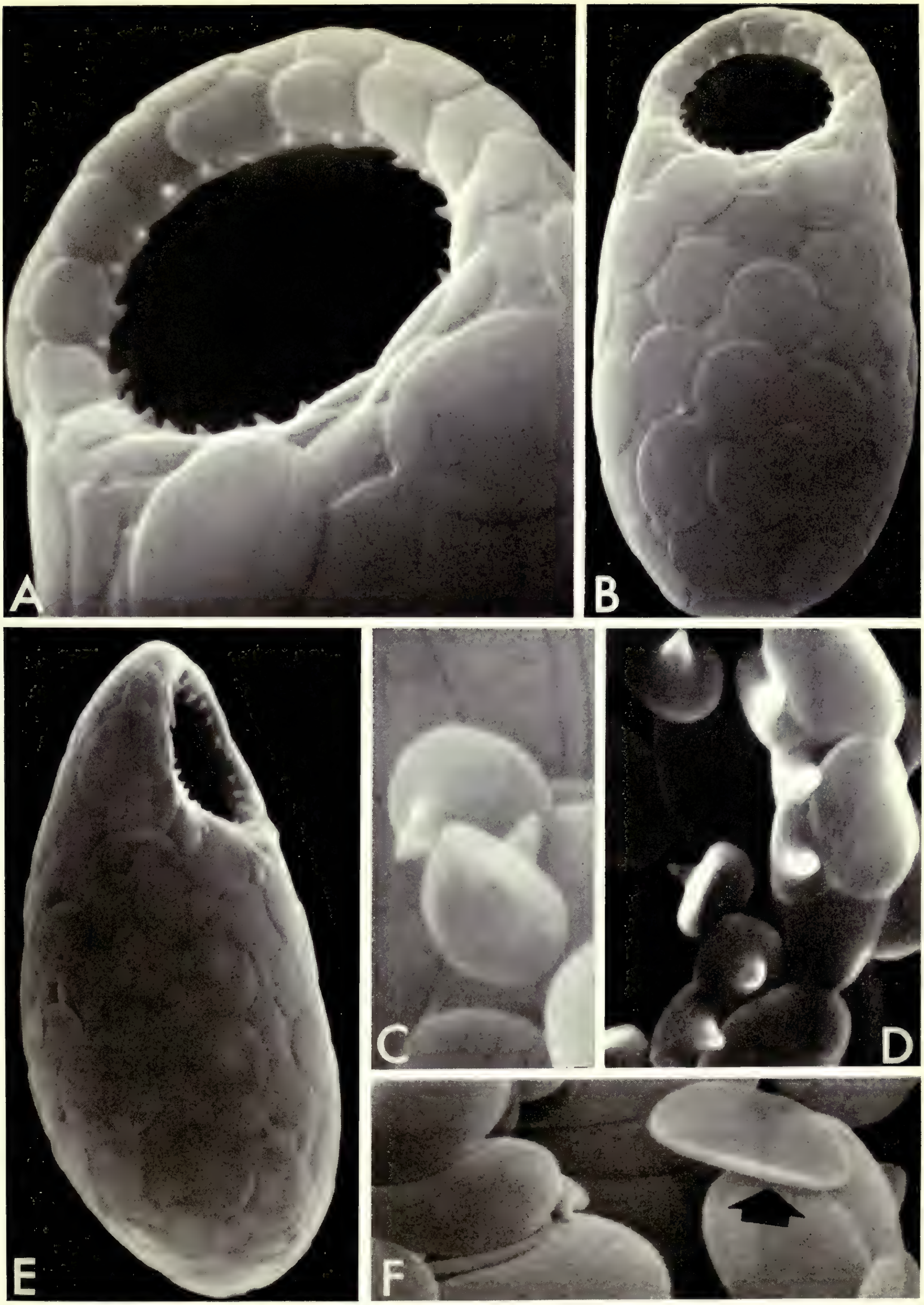
B. Apertural view of *T. lineare* showing the arrangement of large, circular shell-plates. × 2900

C. Two apertural plates ; the lower one shows a characteristic median fold. × 23 000

D. A preparation from which the organic cement has been removed illustrating the arrangement of apertural and small shell-plates. × 8650

E. Lateral view of *T. lineare* illustrating the oblique position of the aperture. × 2900

F. Individual shell-plates ; note the fold in small shell-plate (arrowed). × 11 500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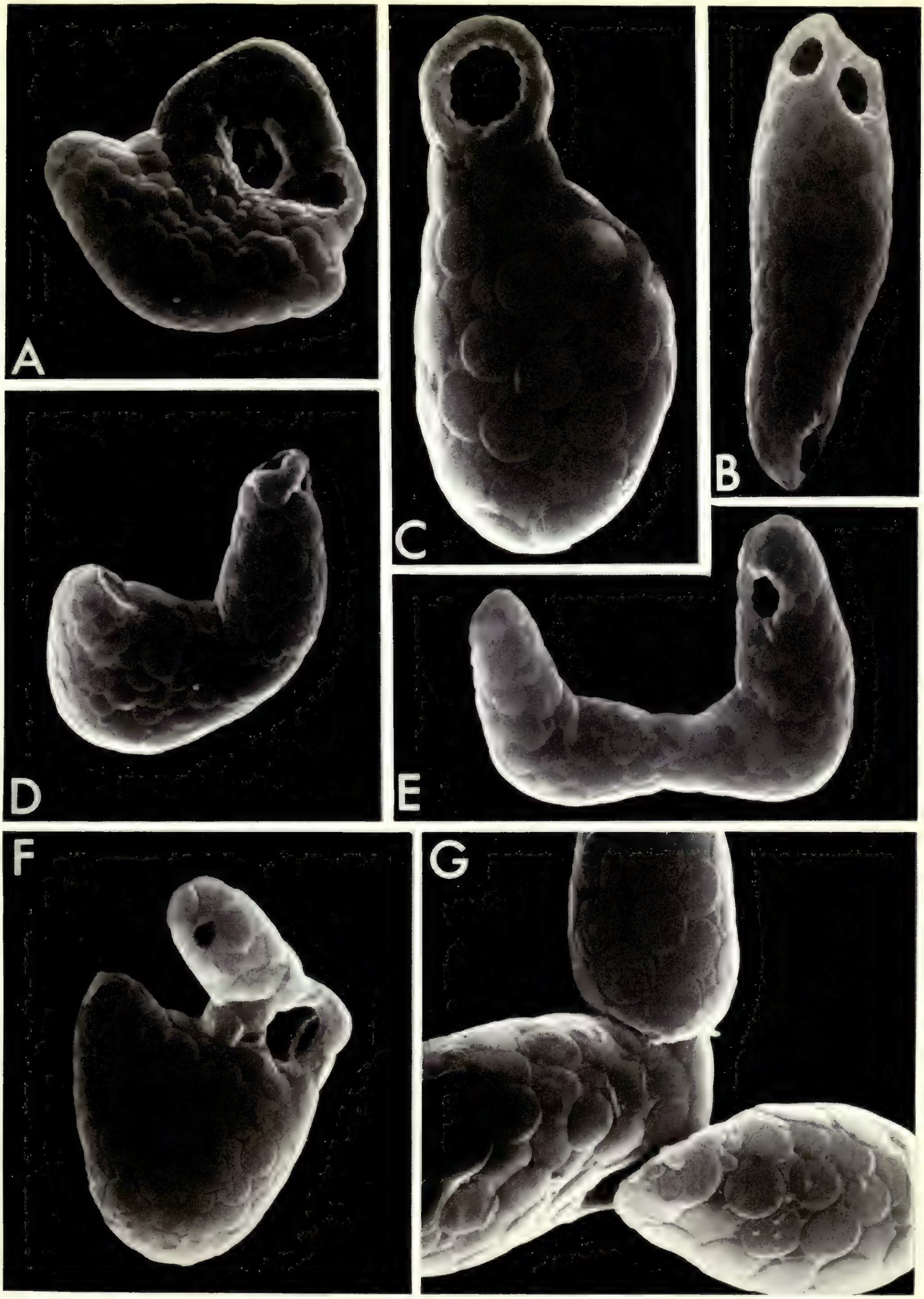
## PLATE 2

A–F. Abnormal variants of *T. lineare*; note that the apparent imbrications are due possibly to electrons penetrating the borders of the shell-plates, these are not seen when the accelerating voltage on the scanning electron microscope is reduced.
A, B, D, E and F × 1000 C × 2000

G. Groups of three animals in 'rosette' formation. × 1400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## PLATE 3

A. Longitudinal section showing the pigment zone (pz), electron-dense inclusion (i), granular endoplasmic reticulum (ger), nucleus (n) and Golgi apparatus (G). × 4300

B. Section showing various vacuoles containing bacteria (b), microbodies (m), and the probable stages in the development of electron-dense particles (stages 1–3) – stage 4 is shown in fig. A. × 15 950

C. Section showing vesicles containing fibrillar material (fm) concentrated in the centre with radiating strands. × 23 900

D. Transverse section showing three contractile vacuoles (cv) which are at systole, nucleus (n) and the concentrated mass of perinuclear endoplasmic reticulum (ger). × 7800

PLATE 3

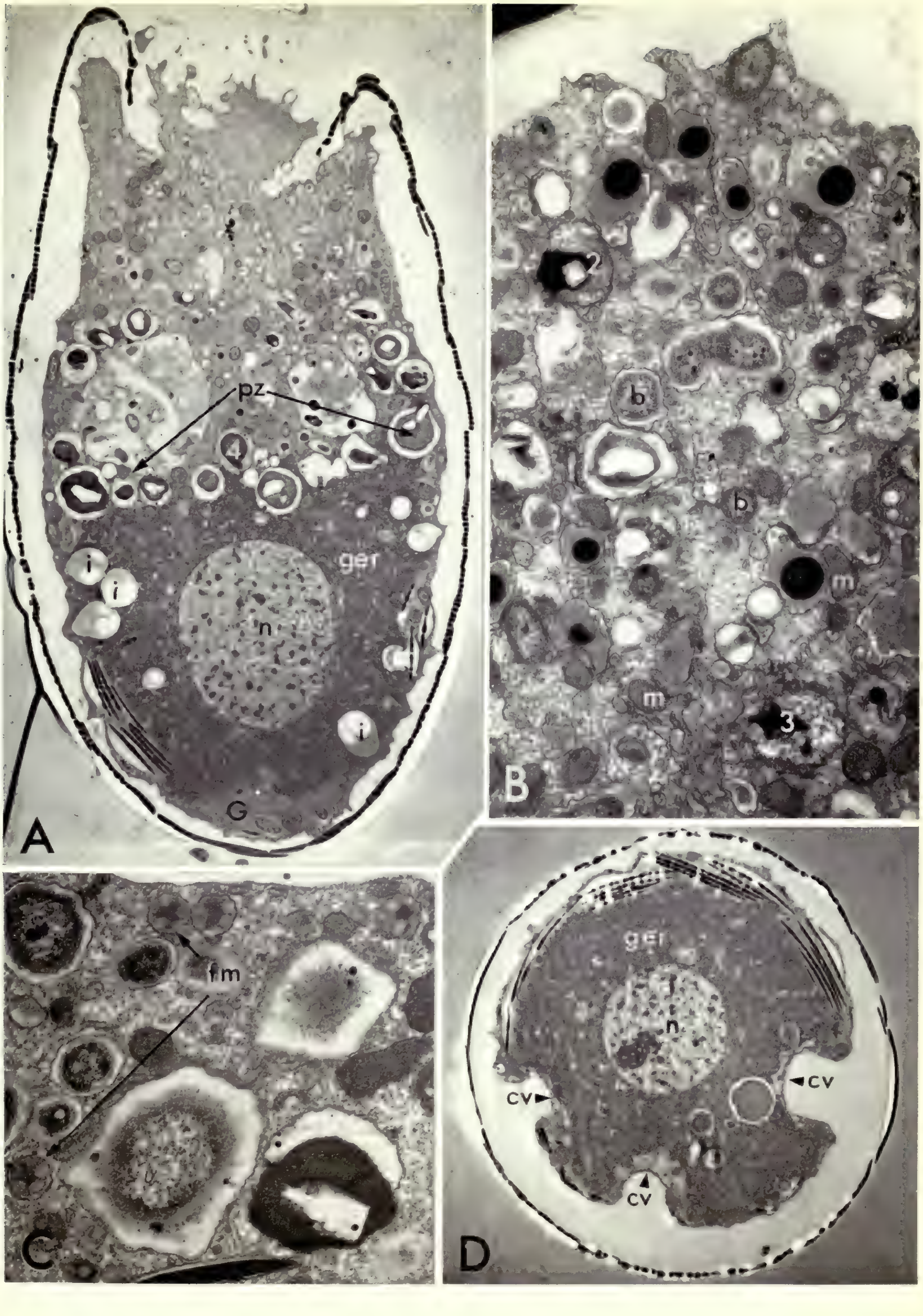
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PLATE 4

A. Longitudinal section showing the position and ovoid shape of the nucleus (n) at prophase, Golgi apparatus (G), the cytoplasmic attachments to the shell and the concentrated mass of perinuclear endoplasmic reticulum (ger.). × 7800

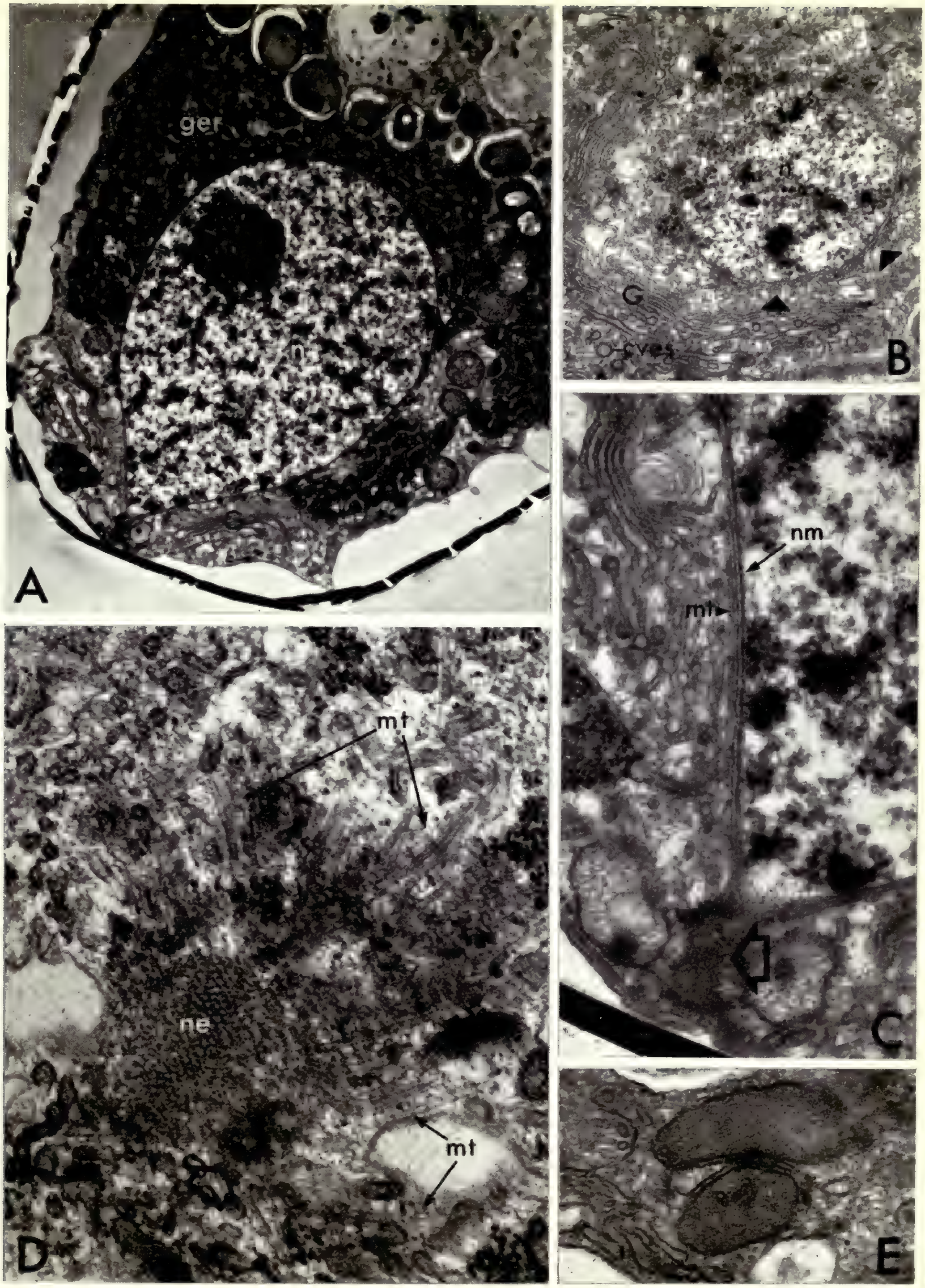
B. Cross-section of the posterior region of nucleus (n) showing proximity of numerous microtubules (arrowed), Golgi apparatus (G) and coated vesicles (cves). × 20 750

C. Section showing microtubule (mt) close to nuclear membrane (nm) and the terminal position of the microtubule-organizing-centre, MTOC (arrowed). × 30 100

D. Section immediately posterior to the nucleus showing nuclear envelope (ne) and numerous microtubules (mt) converging onto microtubule-organizing-centre, MTOC (arrowed). × 56 700

E. Section through two microbodies showing tubular elements. × 44 600

PLATE 4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## PLATE 5

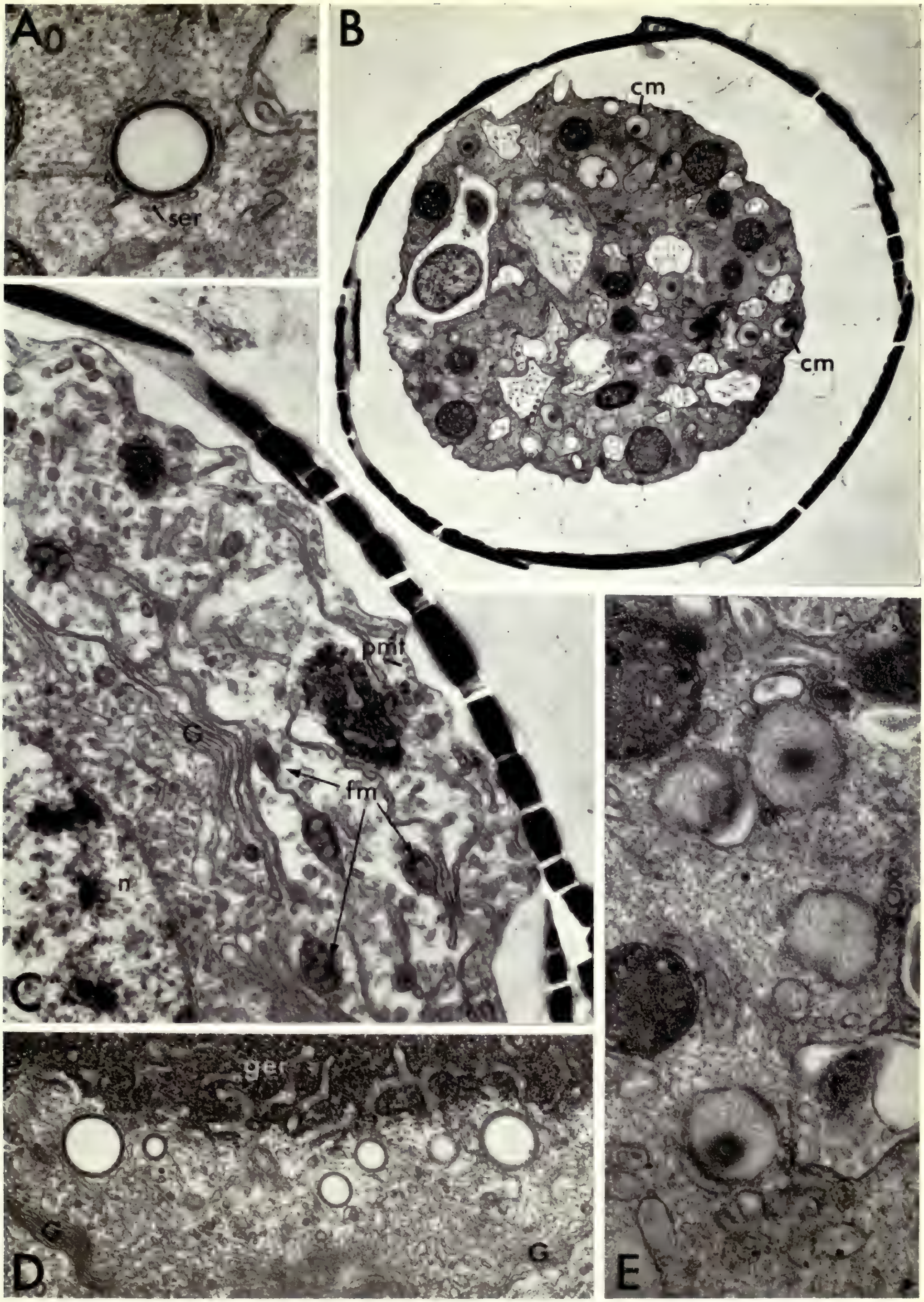
A. Vesicle with double-unit membrane and enclosed by smooth endoplasmic reticulum (ser) (see also fig. D). × 30 100

B. Transverse section through anterior region of cytoplasm showing numerous cement bodies (cm) and thin cytoplasmic strands in the space between cytoplasm and shell. × 10 400

C. Section showing Golgi apparatus (G) with concentrations of fibrillar material (fm) in the saccules, nucleus (n) and pellicular microtubules (pmt). × 22 300

D. Probable origin of electron-transparent vesicles in the region between granular endoplasmic reticulum (ger) and Golgi apparatus (G) (see also fig. A). × 20 050

E. Cement bodies with fibrillar matrix and electron-dense centres. × 40 100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## PLATE 6

A. Section through equatorial region of nucleus (n) showing surrounding microtubules (arrowed). × 30 100

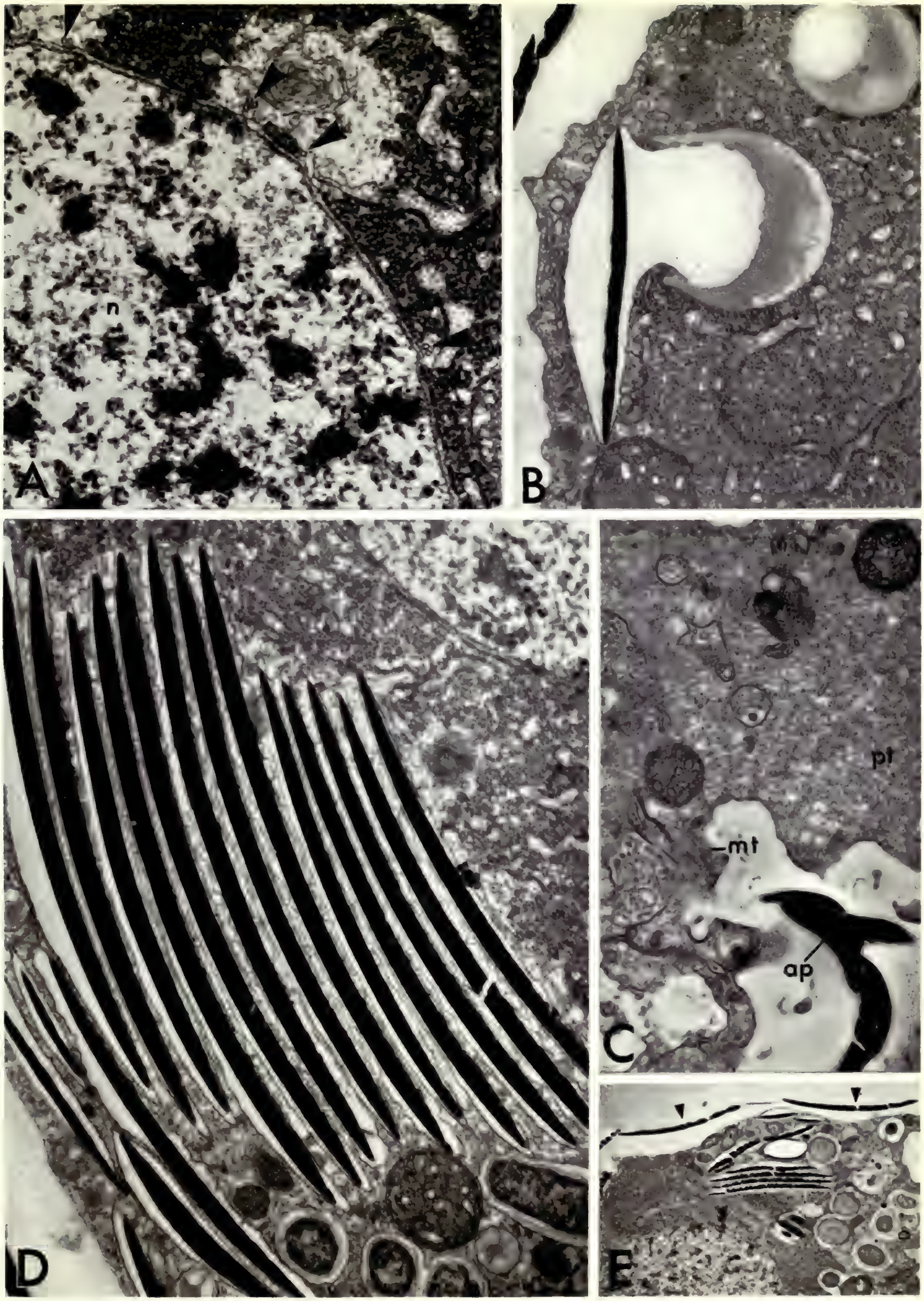
B. Fusion of electron-dense inclusion with reserve shell-plate vesicle. × 22 300

C. Section through apertural region showing internal microtubules (mt), apertural plate (ap) and pseudopodial trunk (pt) which is relatively structureless. × 15 000

D. Stack of reserve shell-plates each in separate membrane-bound vesicle. × 22 300

E. Portion of shell showing shell-plates (arrowed) with concave surface outwards. × 4300

PLATE 6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## PLATE 7

A. Glutaraldehyde-fixed and unstained section showing the arrangement of reserve shell-plates. × 4300

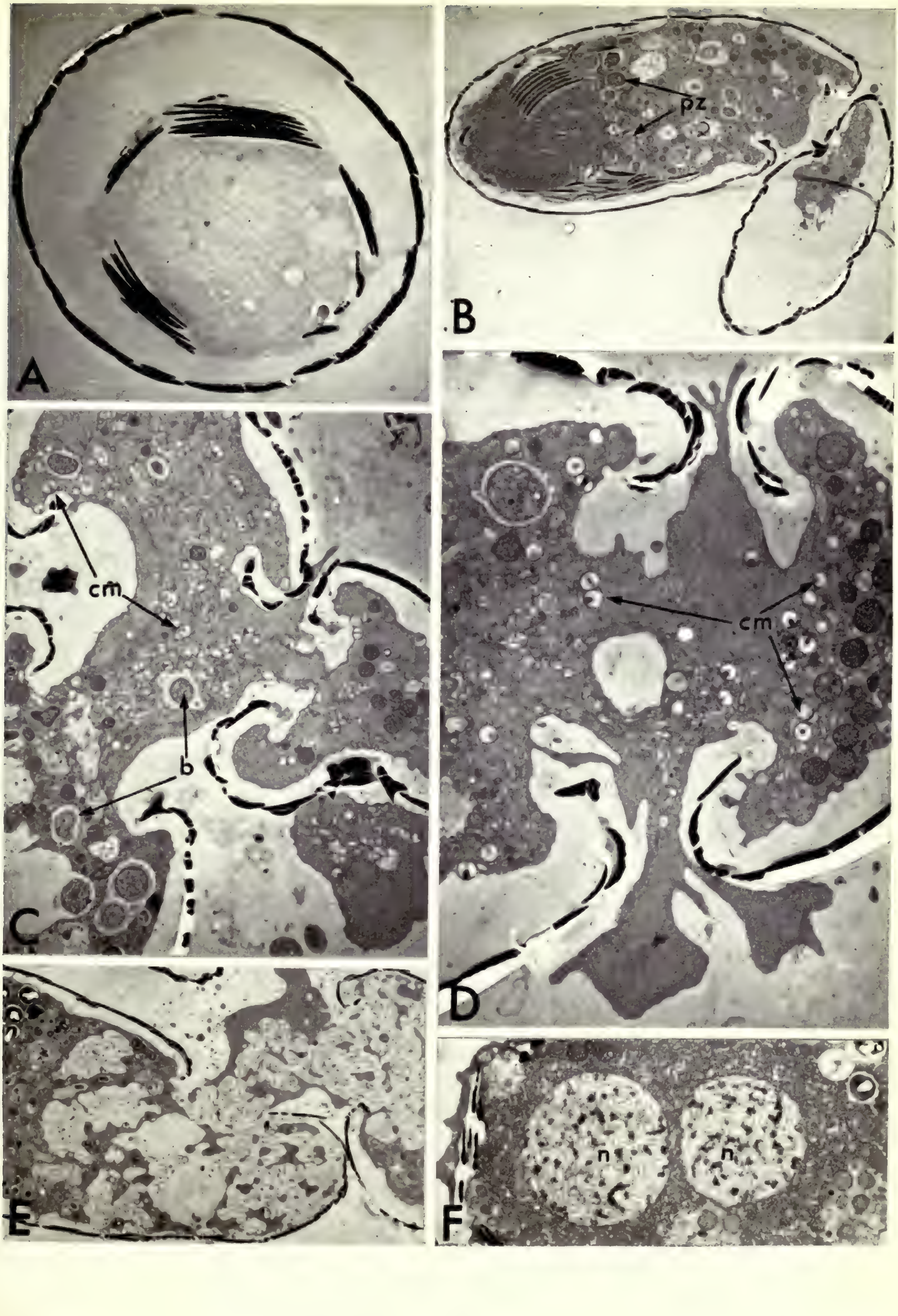
B. Section of two animals directly apposed ; note the larger individual contains numerous reserve plates and a well-defined pigment zone (pz). × 2100

C. Apertural region of a 'rosette' group of four individuals ; note the presence of vacuoles containing bacteria (b) and the numerous cement bodies (cm). × 4300

D. Section through two united adult specimens showing cement bodies (cm) and pseudopodial extensions ; note the structureless nature of the pseudopodia. × 7800

E. A 'rosette' group of three animals showing the diffuse nature of the cytoplasm. × 2800

F. Abnormal individual with two nuclei. × 5750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*Printed in Great Britain by John Wright and Sons Ltd. at The Stonebridge Press, Bristol BS4 5NU*

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B. G. M. JAMIESON

BULLETIN OF
THE BRITISH MUSEUM (NATURAL HISTORY)
ZOOLOGY Vol. 26 No. 4
LONDON : 1974

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# THE INDIGENOUS EARTHWORMS (MEGASCOLECIDAE: OLIGOCHAETA) OF TASMANIA

BY
BARRIE GILLEAN MOLYNEUX JAMIESON
University of Queensland

*Pp.* 201–328 ; 10 *Plates* ; 32 *Text-figures*

BULLETIN OF
THE BRITISH MUSEUM (NATURAL HISTORY)
ZOOLOGY Vol. 26 No. 4
LONDON: 1974

THE BULLETIN OF THE BRITISH MUSEUM (NATURAL HISTORY), *instituted in* 1949, *is issued in five series corresponding to the Departments of the Museum, and an Historical series.*

*Parts will appear at irregular intervals as they become ready. Volumes will contain about three or four hundred pages, and will not necessarily be completed within one calendar year.*

*In* 1965 *a separate supplementary series of longer papers was instituted, numbered serially for each Department.*

*This paper is Vol.* 26, *No.* 4 *of the Zoological series. The abbreviated titles of periodicals cited follow those of the World List of Scientific Periodicals.*

*World List* abbreviation :
*Bull. Br. Mus. nat. Hist.* (Zool.).

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# THE INDIGENOUS EARTHWORMS (MEGASCOLECIDAE: OLIGOCHAETA) OF TASMANIA

*By* B. G. M. JAMIESON

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## SYNOPSIS

This paper raises the number of indigenous earthworms known from Tasmania to forty-eight, in ten genera. The genus *Perionychella* Michaelsen, 1907a, is re-established and extended to include lumbricine species with or without nephridial bladders and perichaetine, vesiculate species. The other species resemble the type-species in being perichaetine with avesiculate nephridia. All vesiculate species are included in the subgenus *Vesiculodrilus* Jamieson, 1973a, initially established as a genus for lumbricine, vesiculate species. *Perionychella* absorbs all Australian species of *Diporochaeta*, which is now regarded as endemic in New Zealand, and a large portion of the residue of *Plutellus*, a genus which has been revised elsewhere. A check list of the two subgenera of *Perionychella* is given which lists twenty-three Tasmanian species. *Perionychella* is therefore the dominant genus in numbers of species in Tasmania, as in Victoria. Twelve of the Tasmanian *Perionychella* species are new species and a further five species are redescribed, three of these from new material. Only *P. scolecoidea* (Spencer, 1895) was previously referred to the genus (*Michaelsen*, 1907a).

The remaining earthworm fauna consists of a new species and the first Tasmanian record of *Rhododrilus*; a new species, also the first record, of *Graliophilus*; the new genus *Pinguidrilus* erected for *Notoscolex tasmanianus* Fletcher; a species of *Woodwardiella* which, like the *Graliophilus* species, may be referable to *Perionychella*; eight species of *Cryptodrilus*, of which four and one subspecies are new ; a new species of the formerly monotypic Victorian genus *Pseudocryptodrilus* ; a new monotypic genus *Hickmaniella* ; eight species of *Oreoscolex*, of which four are new, and three species provisionally referred to *Megascolex*, of which two are new. There is almost total specific endemicity in Tasmania, a single species, *Megascolex tasmanicus*, being questionably a junior synonym of a mainland species. In contrast only two of the ten genera are endemic, the remaining eight occurring on the mainland and five of these in Victoria, the region with the highest zoogeographic affinity with Tasmania. Noteworthy features of the Tasmanian fauna are the high species diversity relative to the area of the island (paralleled, however, in Victoria), the high proportion of primitive, chiefly perionychin genera and species ; and radiative evolution in the excretory system within the perionychin genus *Cryptodrilus* which has resulted in convergent acquisition of grades of organization characteristic of the tribes Dichogastrini and Megascolecini, these tribes being poorly represented in Tasmania.

## INTRODUCTION

THE earthworms of Tasmania have not been reviewed since the original work of Spencer (1895). As a result of the kind cooperation of Mr A. J. Dartnall of the Tasmanian Museum and Art Gallery, Hobart, and of Dr J. L. Hickman of the Zoology Department, University of Tasmania, in placing their oligochaete collections at the author's disposal, the taxonomic and zoogeographic relationships of the Tasmanian earthworm fauna have been investigated and the number of known species from that island has more than doubled. The present paper is a report of these investigations.

Before the study was begun, the known oligochaete fauna of Tasmania consisted of six species of aquatic microdriles, twenty-three indigenous species of megascolecid earthworms, and introduced earthworms of the family Lumbricidae. The microdriles are the cosmopolitan and probably anthropochorous *Lumbriculus variegatus* (Muller, 1774) (Lumbriculidae) ; the endemic *Telmatodrilus multiprostatus* and *T. pectinatus*, both of Brinkhurst 1971 ; *Antipodrilus davidis* (Benham, 1907) which also occurs in Australia and New Zealand ; the cosmopolitan *Limnodrilus udekemianus* Claparede, 1862 (all Tubificidae) ; and the species inquirenda, *Tasmaniaedrilus tasmaniaensis* Goddard and Malan, 1913 (Phreodrilidae).

The previously known indigenous earthworms are listed below under their original binomina. Generic identifications were rarely correct but the species are reassigned and all previous generic attributions are listed in the specific synonymies.

Species of Spencer, 1895 :

*Cryptodrilus irregularis*
  *polynephricus*
  *mortoni*
  *hobartensis*
  *campestris*
  *tesselatus*
  *insularis*
  *ellisi*
  *wellingtonensis*
  *officeri*

*Megascolides simsoni*
  *bassanus*
*Perichaeta tasmanica*
  *moroea*
  *richea*
  *dilwynnia*
  *scolecoidea*
  *irregularis*

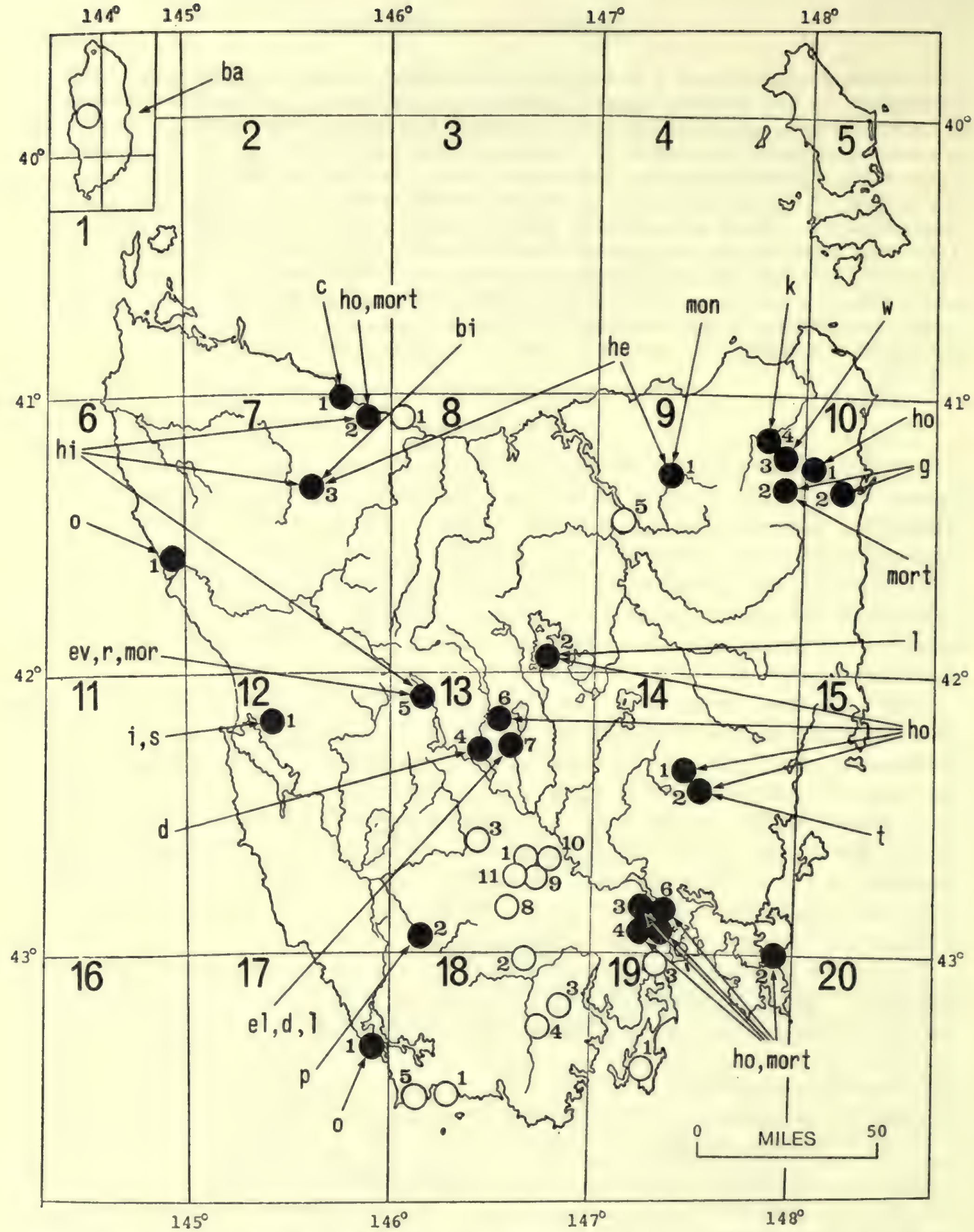
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FIG. 1. Tasmanian records of *Perionychella* species. ●, present; ○, absent; ba, *P. bassana*; bi, *P.* (*V.*) *bithecata*; c. *P.* (*P.*) *capensis*; d, *P.* (*V.*) *dilwynnia*; el, *P. ellisi*; ev, *P.* (*V.*) *evansi*; g, *P.* (*V.*) *glandifera*; he, *P.* (*V.*) *hellyeri*; hi, *P.* (*V.*) *hickmani*; ho, *P.* (*V.*) *hobartensis*; i, *P.* (*P.*) *irregularis*; k, *P.* (*P.*) *kershawi*; l, *P.* (*P.*) *lacustris*; mon, *P.* (*V.*) *montisarthuri*; mor, *P. moroea*; mort, *P.* (*V.*) *mortoni*; o, *P.* (*V.*) *obliquae*; p, *P.* (*V.*) *pedderensis*; r, *P. richea*; s, *P. scolecoidea*; t, *P.* (*V.*) *tunnackensis*; w, *P.* (*P.*) *weldboroughi*. Not mapped: *P. decatheca*. (Numerals pertain to map references in text.)

Further species :

| | |
|---|---|
| *Notoscolex tasmanianus* Fletcher, 1888b | *Notoscolex leai* Michaelsen, 1910 |
| *Megascolides albertsi* Cognetti, 1910 | *Perionyx lacustris* Stephenson, 1924 |
| *Plutellus decatheca* Michaelsen, 1910 | |

## EXPLANATION OF DESCRIPTIVE FORMAT AND TERMINOLOGY

Those unfamiliar with oligochaete morphology and terminology are referred to Stephenson (1930) for what remains the most comprehensive account of this subject. It should be noted, however, that the taxonomy employed by Stephenson is now largely obsolete. In the following explanation of the format used in describing species in the present work some additional clarification of terminology will be given.

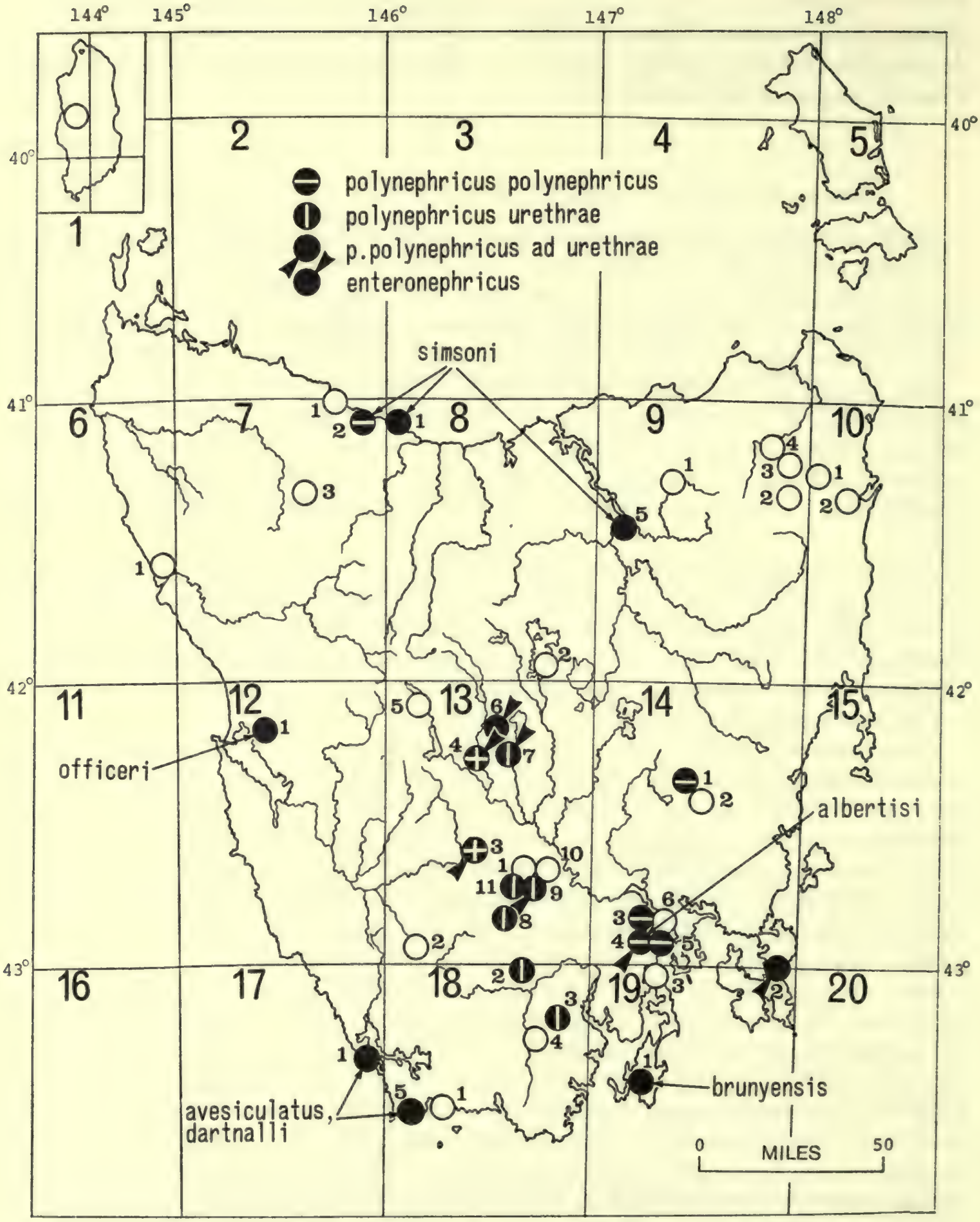
The descriptive format has been kept brief. Some characters, e.g. septal thickening, which are customarily described but are of limited value are omitted in favour of fuller treatment of systems of major significance in taxonomy which are frequently neglected, such as the excretory system. Some information retrievable from the illustrations, e.g. spermathecal proportions and dimensions, is excluded from the text.

These preliminary accounts are primarily limited to a holotype and paratype but variation, particularly in the highly species-specific genital fields, is appended. For species with eight setae per segment, setal ratios, which are population-specific (Jamieson and Bradbury 1972), are given for several specimens where these are available. Specimens are sexual, and usually clitellate, unless otherwise stated.

Characters employed, in sequence are as follows.

*Dimensions* : l = length, w = midclitellar, or greatest width where accounts are drawn only from the literature, s = number of segments. These and other numerical data are given in the sequence holotype and paratype 1. *Prostomium* whether epilobous or tanylobous and canaliculate (with middorsal longitudinal groove or not). *Body form* is mentioned only where the cross section departs from an approximate circle. The anus is terminal in all cases. Position of the *first dorsal pore* : determined by parting the intersegmental furrows with a probe or observing expulsion of alcohol when the specimen is immersed temporarily in water.

*Setal ratios* (intersetal distances) : the four setae on each side in a segment are designated, in the ventral to dorsal direction, *a*, *b*, *c* and *d*. The distances *aa* : *ab* : *bc* : *cd* : *dd* : *dc* : *cb* : *ba*, measured by camera lucida, are expressed in the tables relative to a constant total (periphery, *u*) of 100. Direct comparison of ratios between individuals without recourse to additional computations is also facilitated by stating the distances as ratios relative to one of the distances (*ab*) expressed as unity. Where there are more than eight setae per segment (the perichaetine condition), the longitudinal setal rows are designated, in the ventral to dorsal direction, setal line 1, 2, 3, etc. but the ventral two rows are alternatively termed *a* and *b*. The dorsalmost row, so as readily to indicate this position, is termed setal line *z* and the penultimate and next ventral rows are *y* and *x* respectively. Setae commence on segment II in all described species.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polynephricus urethrae
p.polynephricus ad urethrae
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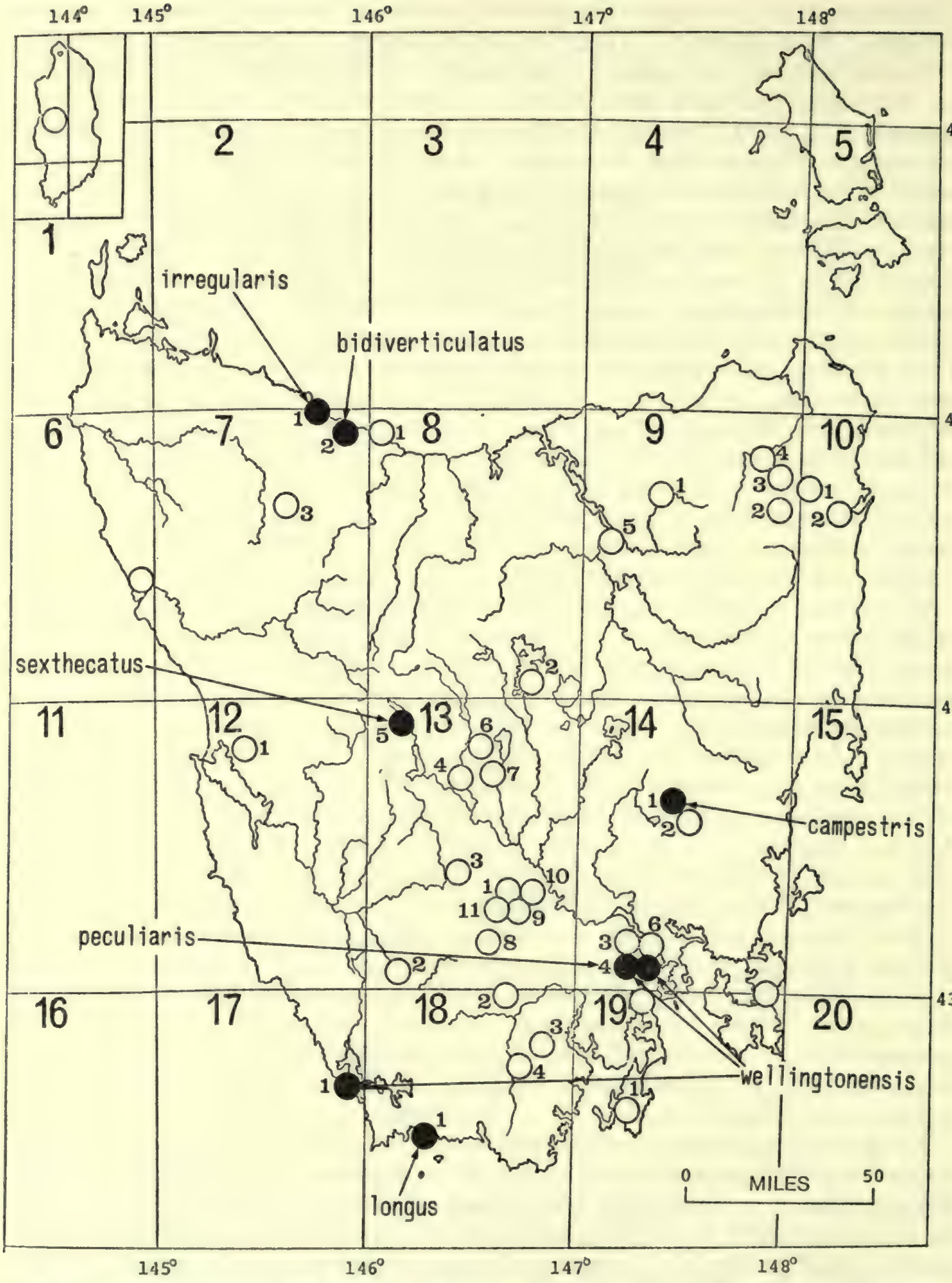
FIG. 2. Tasmanian records of *Cryptodrilus* species and subspecies. ●, present; ○, absent. (Numerals pertain to map references in text.)

*Nephropores* in holonephric Tasmanian species are invariably near the anterior margins of their segments. Their position relative to the setal lines is recorded.

The *clitellum* may be annular, i.e. completely encircling the body, or saddle-shaped, i.e. interrupted ventrally throughout its extent. Segmentation indicated as, for instance, XIII–XVII, indicates that the clitellum extends throughout the mentioned segments, in this case from the anterior border of the thirteenth to the posterior border of the seventeenth segment. A fractional indication, such as ⅓XIII–⅓XVII, indicates the position on the segment at which the clitellum begins or ends, in this case the clitellum would include the posterior two-thirds of XIII and the anterior third of XVII. The *male genital field* is described next, including the position of the porophores bearing the combined pores of the vasa deferentia and the pair of prostate glands, and the form and configuration of accessory genital markings in their vicinity. These markings are usually protuberant, and where an elliptical marking has a distinct central area are described as eye-like. Other accessory genital markings may be present near the spermathecal pores. *Female pores* are without exception paired and anteromedian to setae *a* of segment XIV in Tasmanian species of *Perionychella* but their position is recorded for each species pending description of at least the entire Australian fauna. *Spermathecal pores* are intersegmental or segmental and paired or single in Tasmanian species ; their number, intersegments or segments occupied and location relative to setal lines are indicated.

The internal anatomy (examined after middorsal longitudinal incision) is described in the following sequence. *Blood vascular system* : in all Tasmanian species the dorsal vessel is continuous onto the pharynx and a subneural vessel is absent ; the segment occupied by the last hearts is given and the statement that they are latero-oesophageal refers to their origin from the supra-oesophageal vessel (or the oesophageal plexus). A latero-oesophageal heart usually also receives a connective from the dorsal vessel but this was not always demonstrable in the material examined. The extent of the *supra-oesophageal vessel* is indicated where precisely determinable ; the stated degree of development of the vessel refers to the maximum development in its course. The account of the *alimentary canal* gives the segmental location and degree of development of the gizzard ; modification of the oesophagus, including, where feasible, dilatation and internal specializations such as rugae and lamellae, and the position, if present, of extramural oesophageal (calciferous ?) 'glands' ; the segment of origin of the intestine (determined by intestinal expansion and, where possible, identification of the oesophageal valve between oesophagus and intestine) and presence or absence of a typhlosole. Special muscular thickening of the intestine is present only in *Hickmaniella*. Intestinal caeca are absent in all Tasmanian species of the Megascolecidae.

The types of *nephridia* found in oligochaetes are described by Jamieson (1971a). Nephridia are holonephridia in all species of *Perionychella*, *Graliophilus*, *Pinguidrilus*, *Woodwardiella* and *Rhododrilus* but in some of these holonephric species anterior nephridia are tufted, having numerous tubules, with simple or less commonly composite or multiple ducts ; it remains to be ascertained whether the tufted nephridia always retain the preseptal funnel (the stomate condition) of the simple nephridia. The most anterior segment in which the nephridia were seen to have preseptal funnels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bidiverticulatus
sexthecatus
campestris
peculiaris
wellingtonensis
longus
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FIG. 3. Tasmanian records of *Oreoscolex* species. ●, present; ○, absent. Not mapped: *Oreoscolex leai*. (Numerals pertain to map references in text.)

is stated but it is not to be assumed that funnels were absent from more anterior nephridia as demonstration of funnels is difficult, particularly where disruption of other organ systems is undesirable. Presence or absence of ectal bladders, the vesiculate or avesiculate condition, and their form is recorded, as is the occurrence of diverticula on the bladders.

The *anterior male organs* are described next ; whether holandric (testes and funnels paired in each of X and XI) or metandric (these organs in XI only) and iridescence of the funnels is noted (an indication, albeit only partly reliable, that the organs are functional). Location of seminal vesicles is noted.

*Female organs* in Tasmanian megascolecids are metagynous (ovaries and funnels in XIII) as in all but a few species of the suborder Lumbricina of Brinkhurst and Jamieson 1971. This and the presence or absence of ovisacs (dependent from the anterior wall of XIV) is noted for each species.

The form and extent of the *prostate glands* are recorded ; variation in the form of these is discussed in the introductory discussion of *Perionychella*. *Penial setae* : occurrence of these enlarged copulatory setae in segment XVIII, associated with the male pores, is noted. Lengths of well-developed setae are given and their morphology as revealed by the light microscope and scanning electron microscope is briefly described. The penial setae in Tasmanian species of *Perionychella* are unusually slender and are at most only weakly ornamented, a contrast with other genera on the island, and reproduction of the electron microscope photographs is rarely merited. In several species of *Perionychella* complete or undamaged setae were not recoverable and the morphology could not be elucidated. A study of the degree of inter-specific variation in their ultra-morphology is required.

Finally, the number of *spermathecae* and the form and number of their diverticula are noted, detailed information being retrievable from the illustrations.

*Material examined* : Under this heading are given, in sequence, the locality with habitat data, the longitude and latitude of the locality, the grid reference on the map, the collector's name, the date of collection, and the institutions in which the holotype, paratypes and additional specimens are lodged. Letters and numbers following the abbreviation for the institution are the registration numbers of the institution. Lectotypes and paralectotypes are designations of Jensz and Smith (1969). Abbreviations for the institutions are given below and listed with them are the names of collectors.

*Collectors*

Mr E. A. Bradbury
Mr A. Dartnall
Dr J. W. Evans
Dr J. L. Hickman
Professor V. V. Hickman
Mr W. Jackson
Dr B. G. Jamieson
Mr R. W. Kerr

*Institutions in which specimens are lodged*

| | |
|---|---|
| AM | Australian Museum, Sydney |
| BJ | Author's collections |
| BM(NH) | British Museum (Natural History) |
| NMV | National Museum of Victoria |
| TM | Tasmanian Museum, Hobart |

*Collectors* (*cont.*)

Mr R. C. Kershaw
Mr C. D. King
Mr W. Radford
Tasmanian Biological Survey
Mr D. Tyler

## SYSTEMATICS

The generic and specific descriptions are arranged under the relevant subfamilies and tribes but a key to all Tasmanian genera, ignoring suprageneric ranks, will be given first. This key is intended only for known Tasmanian species of the genera concerned and should not be used as a general diagnostic key for these genera in other regions.

### Key to the genera of Tasmanian Megascolecidae

1 Combined male and prostatic pores a pair on XVII (16th setigerous segment). (Holonephric; bladders absent) . . . . . . . ***RHODODRILUS***
– Combined male and prostatic pores a pair on XVIII (17th setigerous segment). (Holonephric or meronephric; bladders present or absent) . . . . . 2
2 Nephridia one pair per segment (holonephridia) in midbody . . . . . . 3
– Nephridia more than one pair per segment (meronephridia) in midbody . . . 6
3 Nephridial bladders present . . . . . . . . . . . . . 4
– Nephridial bladders absent . . . . . . . . . . . . . 5
4 Nephridia discharging in irregular rows, from *c* to near middorsum. Spermathecae adiverticulate . . . . . . . . . . . . ***PINGUIDRILUS***
– Nephridia discharging in a straight line, in the vicinity of *c* lines. Spermathecae diverticulate . . . . . . ***PERIONYCHELLA (VESICULODRILUS)***
5 Intestinal typhlosole present ***GRALIOPHILUS*** (part; see also ***WOODWARDIELLA***)
– Intestinal typhlosole absent . . . . ***PERIONYCHELLA (PERIONYCHELLA)***
6 Nephridia 2 or 3 on each side except at the caudal extremity which is holonephric ***PSEUDOCRYPTODRILUS***
– Nephridia more than 2 per segment throughout . . . . . . . . . 7
7 Setae more than 8 per segment . . . . . . . . . . . . 8
– Setae 8 per segment . . . . . . . . . . . . . . 9
8 A gizzard present at the beginning of the intestine. Oesophageal gizzard also present . . . . . . . . . . . . . ***HICKMANIELLA***
– Oesophageal gizzard present. Intestinal gizzard absent . . . ***MEGASCOLEX***
9 Caudal nephridia with numerous funnels on each side on the anterior face of each septum. Bladders absent . . . . . . . . . ***OREOSCOLEX***
– Caudal nephridia with at most a single funnel on each side on the anterior face of each septum. Bladders often present . . . . . . . ***CRYPTODRILUS***

## Subfamily **ACANTHODRILINAE**

### Tribe **ACANTHODRILINI** s. Jamieson, 1971a

### Genus ***RHODODRILUS*** Beddard, 1889

Diagnosis. Setae 8 per segment. Prostatic pores 1 pair, on XVII (in one species on XVI); male pores combined with the prostatic pores or 1 pair, usually on XVII close to them, sometimes anterior on XVIII, occasionally associated with the posterior ends of seminal grooves. Female pores 1 pair, on XIV. Spermathecal pores 1–5 pairs, the last pair anterior to 9/10. Nephropores in a single series on each side. Last hearts in XII or XIII. Gizzard single, occupying 1 or 2 segments in the region of V–VIII, usually strongly developed, occasionally small. Holonephric throughout or exceptionally with anterior meronephridia. Nephridial vesicles of various forms or absent. Calciferous glands present or absent. Holandric; gymnorchous. Prostates tubular; penial setae usually present. Spermathecae diverticulate.

TYPE-SPECIES. *Rhododrilus minutus* Beddard, 1889.

DISTRIBUTION. New Zealand and neighbouring islands. Two species in Australia: one in Queensland, the other in Tasmania.

TASMANIAN SPECIES. *Rhododrilus littoralis* sp. n.

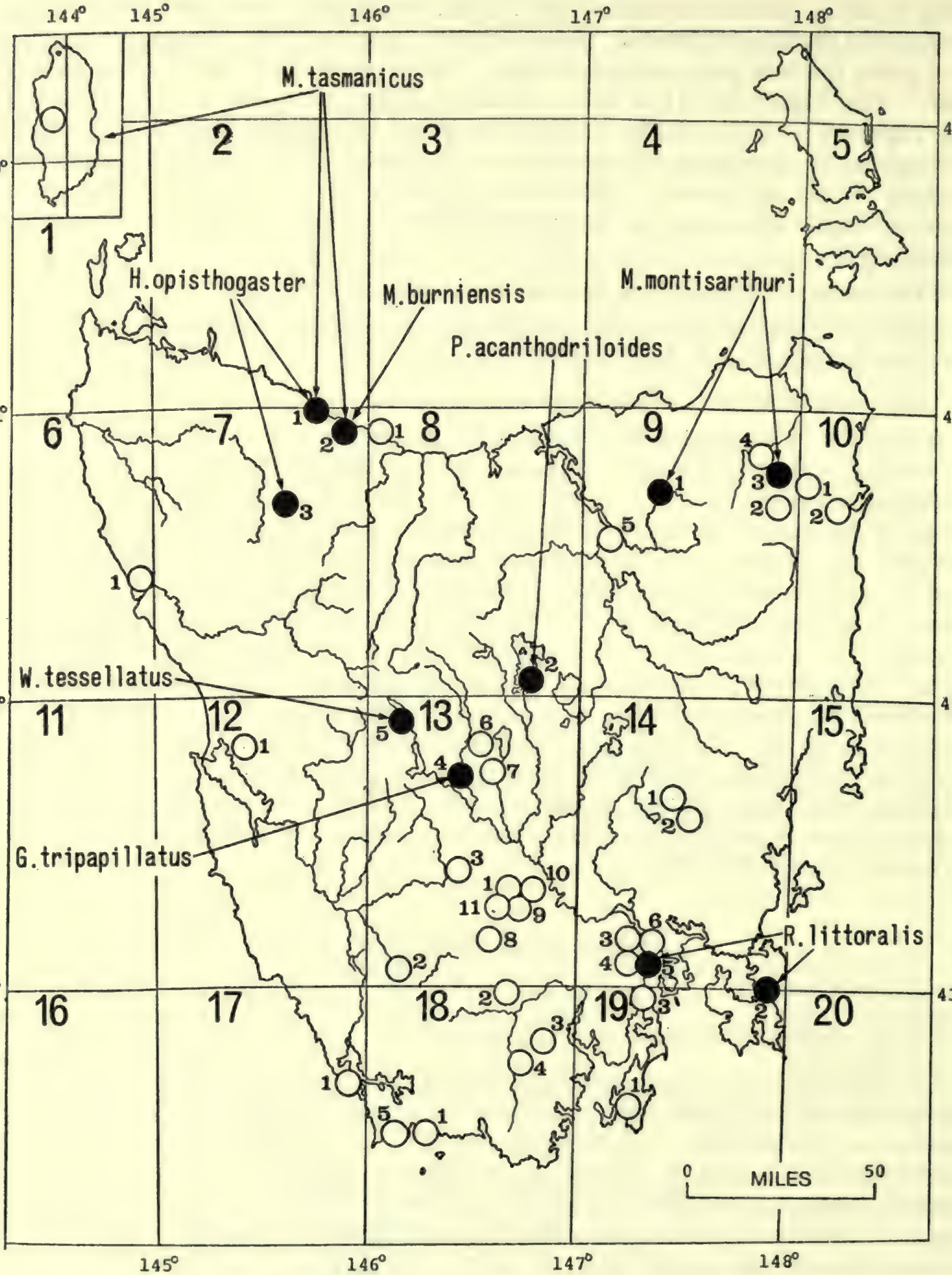
REMARKS. The above generic definition is derived from that of Jamieson (1971b). In the latter work attention was drawn to the unsatisfactory distinction between *Rhododrilus* and *Microscolex.* Although the majority of species of *Microscolex* differ from *Rhododrilus* in having two pairs of prostates, the type-species, *M. phosphoreus* (Dugès), like *M. dubius* (Fletcher), has a single pair of prostates, as in *Rhododrilus,* and has been shown by Lee (1970) to have strong phenetic affinities with the latter genus (including the type-species, *R. minutus*) over which it has chronological priority. It is possible that *Rhododrilus* will have to be synonymized with *Microscolex* and new genera erected for some of the species of the present *Microscolex–Rhododrilus* complex which fall outside a redefined *Microscolex.* The following new Tasmanian species is provisionally placed in *Rhododrilus* because, like some other species of this genus, including the type-species, it lacks nephridial bladders whereas these are invariably present in *Microscolex.* In location of nephropores shortly below *c* lines it resembles *Microscolex dubius,* however, and differs from *Rhododrilus* in which nephropores are in *b* or *c.*

### ***Rhododrilus littoralis*** sp. n.

Fig. 4, 26C, 32E; Plate 60. Table 1

l = 65, 74 mm, w = 2 mm, s = 103, 105.

Setal annuli strongly protuberant, excepting the anterior preclitellar and extreme caudal regions, and demarcated posteriorly by a groove equalling the intersegmental furrows in distinctness. Prostomium epilobous $\frac{2}{3}$, $\frac{1}{2}$, open, margins posteriorly convergent but indistinct. Dorsal pores weakly developed behind the clitellum, possibly present as rudiments in the immediate preclitellar segments. Setae 8 per segment, commencing on II, in regular longitudinal lines throughout; setae *a* and *b* absent (replaced by penial setae) in XVII. Nephropores not externally visible. Clitellum externally indistinct, annular, $\frac{1}{3}$XIII–$\frac{1}{2}$XVIII (= $5\frac{1}{6}$ segments) from dorsal incision (holotype); weakly developed but limits indeterminable in paratype 1. Male pores in XVII, in *b* on small whitish papillae which fill *ab* transversely and


144°
145°
146°
147°
148°
40°
41°
42°
43°
1
2
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4
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10
11
12
13
14
15
16
17
18
19
20
M.tasmanicus
H.opisthogaster
M.burniensis
M.montisarthuri
P.acanthodriloides
W.tessellatus
G.tripapillatus
R.littoralis
0 MILES 50

FIG. 4. Records of Tasmanian megascolecid earthworms excluding *Perionychella*, *Cryptodrilus* and *Oreoscolex* species. ●, present; ○, absent. (Numerals pertain to map references in text.)

occupy the posterior two-thirds of the segment. Accessory genital marking a transverse pad in 19/20, extending laterally shortly beyond *b* lines, and longitudinally abutting on the setal annuli of XIX and XX; strongly tumid and transversely bisected by a furrow corresponding with but not peripherally continuous with intersegmental furrow 19/20 (holotype); genital marking not certainly detectable in paratype 1. Female pores a pair on XIV, midway between the setal arc and anterior margin, very slightly lateral of *a* lines (paratype 1); not certainly demonstrable but apparently concealed in the anterior furrow delimiting the setal annulus in holotype. Spermathecal pores minute, concealed (holotype) or visible with difficulty (paratype 1) in intersegments 7/8 and 8/9, in *b* lines.

TABLE 1

Intersetal distances in segment XII in *Rhododrilus littoralis*

| | | | | mm | | | | |
|---|---|---|---|---|---|---|---|---|
| | *aa* | *ab* | *bc* | *cd* | *dd* | *dc* | *cb* | *ba* |
| holotype | 0·7 | 0·4 | 0·9 | 0·8 | 1·8 | 0·9 | 0·8 | 0·4 |
| paratype 1 | 0·8 | 0·5 | 0·9 | 0·8 | 1·8 | 0·8 | 0·9 | 0·5 |
| | | | | standardized (*u* = 100) | | | | |
| | *aa* | *ab* | *bc* | *cd* | *dd* | *dc* | *cb* | *ba* |
| holotype | 10·00 | 5·79 | 13·16 | 12·63 | 27·36 | 13·16 | 12·11 | 5·79 |
| paratype 1 | 11·22 | 6·63 | 13·27 | 11·73 | 26·02 | 11·22 | 12·76 | 7·14 |
| mean | 10·61 | 6·21 | 13·22 | 12·18 | 26·69 | 12·19 | 12·44 | 6·47 |
| interval/*ab* | 1·71 | 1·00 | 2·13 | 1·96 | 4·30 | 1·96 | 2·00 | 1·04 |

Last hearts in XIII (those in X–XIII latero-oesophageal; with connectives to the dorsal and supra-oesophageal vessel). Supra-oesophageal vessel in VIII ?–XIV; moderately developed. Gizzard small and easily compressible, though muscular, in V (holotype); rudimentary in paratype 1. Oesophagus lacking calciferous glands; especially vascularized and with low internal rugae in VIII–XVI; slender and less vascular in XVII and XVIII; intestine commencing, with dilatation, in XIX ? (holotype, paratype 1); the alimentary canal in XVII and XVIII possibly intestinal, however; typhlosole absent. Nephridia stomate holonephridia, commencing in II, preseptal funnel (demonstrated in intestinal region) large, in *b* line; avesiculate duct entering parietes one-third *bc* below *c*. Holandric; gymnorchous; testes large, much branched; sperm funnels small, faintly iridescent; seminal vesicles racemose, in IX, XI and XII increasing in size posteriorly. Metagynous (ovaries with many egg-strings); ovisacs present (paratype 1); not detectable in holotype. Prostates one pair, very slenderly tubular, in XVII–XXIII (holotype)–XXIV (paratype 1); vas deferens joining the muscular duct well ectal of the gland. Penisetal follicles conspicuous, as wide as the prostates and almost as extensive, extending from XVII–XXII. Penial setae filiform, sinuous; the ectal extremity depressed spatulate; ornamentation absent; length = 2·8–3·7 mm, general width of shaft = 11 μm (paratype 1). Spermathecae 3 pairs, in VII, VIII and IX, each with ovoid ampulla and shorter digitiform (uninseminated) diverticulum on the short, poorly demarcated duct; the spermatheca and diverticulum almost sessile on the body wall.

*Genital markings.* Of 13 paratypes, 11 have the genital field described for the holotype, with a single accessory genital marking, sometimes only faintly indicated, at 19/20; 2 lack the marking but are less mature than the others.

MATERIAL EXAMINED.

Eagle Hawk Neck, in kelp on rocks, 147°55′E. 43°00′S. Map. 19/2, Dr J. L. Hickman, Apr 1956 – holotype TM : K396; paratypes 1 and 4 BM(NH) : 1973.2.53–54; paratypes 2 and 8 BJ : T77–78; paratypes 3, 5–7 TM : K397–400. Hobart, and 'Straham' [possibly Strahan, west coast of Tasmania?] 147°20′E. 42°50′S. Map, 14/5 collector ? AM: G2628 – paratypes 9–13, AM : W5339–5343.

REMARKS. *R. littoralis* differs from all other species of the genus in the configuration of the male genital field. The other Australian species, *R. queenslandica*, differs among other respects in having only one pair of spermathecae.

## Subfamily **MEGASCOLECINAE**

### Tribe **PERIONYCHINI** Jamieson, 1971a

### Genus ***PERIONYCHELLA*** Michaelsen, 1907a emend.

DIAGNOSIS. Setae 8 or more per segment. Combined pores of vasa deferentia and tubular or tubuloracemose prostates on XVIII. Gizzard in V, rarely VI or VII (well developed to vestigial); typhlosole absent. Extramural calciferous glands usually absent, and never paired, but the oesophagus often vascularized and internally rugose, especially in XIV and XV. Nephridia stomate, exonephric holonephridia with or without bladders; the anterior nephridia sometimes tufted. Spermathecae 1 to 5 pairs.

DESCRIPTION. Terrestrial or rarely aquatic worms. Form circular in cross section or depressed; anus terminal; with or without pigmentation. Dorsal pores present or absent, usually commencing in 3/4 or 4/5. Setae 8 per segment throughout (lumbricine condition) or becoming more numerous (perichaetine condition) after a varying number of anterior segments, or perichaetine throughout. Nephropores in a single series throughout in the vicinity of *c* lines (where setae are lumbricine) or their equivalent in perichaetine species. Posterior limit of clitellum shortly anterior to the male pores or (*P.* (*P.*) *canaliculatus* and *phalacrus*) including these. A pair of pores of the combined vasa deferentia and a pair of tubular, tubuloracemose or racemose prostates on XVIII. Female pores paired or exceptionally single midventral, in XIV. Spermathecal pores 1 to (usually) 5 pairs in front of or usually including intersegment 8/9. Accessory genital markings present in the vicinity of the male pores and sometimes of the spermathecal pores.

Last hearts in XII or (*P.* (*V.*) *grandis*) XIII. Supra-oesophageal vessel (always ?) restricted to the post-gizzard oesophagus, moderately to well developed, sometimes not differentiated from the oesophageal plexus. Subneural vessel absent. Gizzard in V or exceptionally in VI, frequently only moderately developed or vestigial (in some northern Queensland species in VII). Oesophagus commonly with internal rugae, these often best developed in XIV and XV; sometimes with internal laminae which exceptionally line one or more annular, unpaired, axial calciferous glands. Intestine commencing in XVI–XX, usually XVII; typhlosole, muscular thickening and caeca absent or exceptionally, a rudimentary typhlosole-like dorsal ridge present. Nephridia simple, exonephric holonephridia throughout, or rarely preceded in anterior segments by tufted nephridia with simple or (*P.* (*P.*) *davallia*) composite ducts. Ectal nephridial bladders present (*Vesiculodrilus*) or absent (*Perionychella*); tufted nephridia retaining bladders in vesiculate species. Holandric (testes in X and XI), with seminal vesicles in IX and XII or rarely also in X, or X and XI, or in XI and XII; or rarely metandric, with anterior testes and seminal vesicles reduced or absent. Metagynous (ovaries in XIII); ovisacs present or absent. Prostates tubular, with central lumen, though often flattened, or tubuloracemose (i.e. lobulated to externally racemose but with axial lumen with (or without ?) side branches). Vasa deferentia usually joining the ectal end of the prostate gland, occasionally the junction of gland and duct. Penial setae usually present. Spermathecae with single, clavate or digitiform, uniloculate diverticulum.

DISTRIBUTION. Eastern Subregion of Australia: mostly in Victoria but extending northwards to the Atherton Tableland in North Queensland and with a morphologically isolated species near Cooktown. The dominant genus in Tasmania.

REMARKS. The genus *Perionychella* was established by Michaelsen (1907a) for four eastern Australian species: *Perichaeta dendyi* Spencer, 1892b, and *Megascolex pritchardi* Spencer, 1900, both from Victoria; *Perichaeta canaliculata* Fletcher, 1888a, from north Queensland; and *P. scolecoidea* Spencer, 1895, from Tasmania. Michaelsen's diagnosis of *Perionychella* was: setae at least in the mid- and hind-body many (more than 8) per segment. Spermathecal pores 2–4 (–5 ?) pairs between segments IV and IX. 1 gizzard, in segment 5 or 6. Completely meganephric (holonephric). Prostates with branched canal system.

The only expressed difference from the typically southwestern Australian *Woodwardia* (now *Woodwardiella* Stephenson, 1925) was the increase in setal numbers beyond 8 per segment. The status of *Woodwardiella* is discussed on p. 219.

In 1916 Michaelsen emended the definition of the genus *Perionyx* Perrier, 1872, to agree in all essentials with that of *Perionychella*, which was therefore suppressed, and included *Diporochaeta* Beddard in *Perionyx* as a subgenus. The subgenus *Perionyx* was distinguished by branching of the prostate duct on entering the gland (*Pheretima* prostate) while in *Diporochaeta* the gland possessed a central axial lumen with or without branched or unbranched lateral canals. *Perionychella dendyi* (like *P. canaliculata*) was shown to have the *Diporochaeta* condition, with lateral canals, and was placed in that subgenus. Stephenson (1923) reinstated *Diporochaeta* as a separate genus while suggesting a close relationship with *Perionyx*. *Perionychella* remained suppressed in *Diporochaeta*. Gates (1959) placed *Diporochaeta* and *Perionyx* in different families, the redefined Acanthodrilidae and Megascolecidae respectively. Jamieson (1971a) demonstrated that the grounds for distinguishing the two families were invalid and, having redefined and reconstituted the two entities, reduced them to subfamilial rank in the Megascolecidae. Restriction of *Perionyx* to oriental species (Gates, 1960) was accepted and 40 Australian species were provisionally referred to the genus *Diporochaeta*. It was suggested that revision of *Diporochaeta* required consideration of certain species placed in *Plutellus* which were distinguished solely by the numbers of setae and that it would necessitate establishment of several new genera. It was also proposed that *Perionychella* should be resurrected for *Perichaeta dendyi* as it was clearly not congeneric with the New Zealand type-species of *Diporochaeta* (see p. 219). Relationship of *Perionyx* and *Diporochaeta* s. lat. was acknowledged by placing the two genera, with other holonephric megascolecine genera, in the new tribe Perionychini.

Revision of *Plutellus* is now far advanced and has involved resurrection of *Argilophilus* Eisen for American species, and division of the Australian species, after reinstatement of *Fletcherodrilus* Michaelsen, into the genera *Plutellus* s. strict., *Simsia* Jamieson, 1972a; *Graliophilus* Jamieson, 1971e, and *Vesiculodrilus* Jamieson, 1973a. In the latter paper attention was drawn to the close morphological affinity of *Vesiculodrilus* with similarly vesiculate Australian species of *Diporochaeta* s. lat.

The Tasmanian fauna provides the key to revision of *Diporochaeta* in Australia, and to the relationships of *Vesiculodrilus*, as vesiculate perichaetine species which would formerly have been assignable to *Diporochaeta* s. Stephenson are seen to have morphological (phenetic) affinities, which are unequivocally intrageneric, with species attributable to *Vesiculodrilus*. Transference of these perichaetine species to *Vesiculodrilus* greatly reduces the numbers of species in *Diporochaeta* but leaves a large residue of species either lacking nephridial bladders (avesiculate species) or with the condition of the nephridial duct undescribed. The Tasmanian fauna, again, allows determination of the affinities of the avesiculate species as most of these on the island show high morphological similarities with *Vesiculodrilus*. They are also indistinguishable from *Perionychella*, of which the Victorian type-species is avesiculate. (Variation in form of the prostates from tubular to racemose is considered unimportant as all intermediates are seen, author's examination.) It thus appears that *Vesiculodrilus* must be included in *Perionychella*, a prior genus which has been suppressed for nearly sixty years.

It is here proposed that *Vesiculodrilus* be retained as a subgenus of *Perionychella* distinguished from the nominate subgenus (*P.* (*Perionychella*)) in possessing nephridial vesicles. It is possible that some species of *Vesiculodrilus* may be morphologically closer to avesiculate *Perionychella* species than to species in their own subgenus (and *vice versa*), but recognition of the two subgenera achieves one of the aims of practical taxonomy, convenience. Separation of *Vesiculodrilus* from *Perionychella* also finds some support in setal ratios (Table 1) though whether the distinction by ratios will be upheld should additional lumbricine species of the latter subgenus be found remains to be seen. Thus, for Tasmanian species at least, $dd = 2{\cdot}0\text{–}3{\cdot}1ab, 0{\cdot}18\text{–}0{\cdot}22u$ in *Vesiculodrilus* (with the exception of the morphologically very isolated *P.* (*V.*) *glandifera* in which $dd = 5{\cdot}6ab, 0{\cdot}27u$) while in the two lumbricine species of *Perionychella* $dd = 6{\cdot}5\text{–}7{\cdot}8ab, 0{\cdot}33\text{–}0{\cdot}39u$. Furthermore, while recognition of *Vesiculodrilus* species presents little difficulty, there may be some difficulty in ascertaining whether an avesiculate specimen should be referred to the subgenus *Perionychella* or to other similarly holonephric genera (particularly the Western Australia avesiculate *Graliophilus*) or merits recognition of a new genus. (It should be noted that the difficulty in distinguishing between avesiculate *Perionychella* species and *Graliophilus* stems largely from paucity of knowledge of some species-groups of *Graliophilus* and that it is not proposed that *Graliophilus* should be united with *Perionychella*. Rather, as suggested by Jamieson (1971e), *Graliophilus* requires splitting into further genera.) Reinstatement of *Perionychella* is necessitated by the rules of priority but Michaelsen's definition of *Perionychella* does not diagnose the majority of species of the genus as emended and enlarged on the basis of consideration of large numbers of characters, i.e. overall phenetic resemblance of constituent species, and an emended definition is therefore required. It will be shown that the only characters which are constant throughout the emended genus are general characters of suprageneric, often ordinal or subordinal significance. The genus is thus polythetic, that is to say characters of generic significance are not present in all constituent species but jointly associate these species at a high level of similarity. Furthermore, several generic characters, such as nephridial bladders and five pairs of spermathecae, are constant for the majority of species and give striking morphological homogeneity to these species which can often only be distinguished with certainty by the configuration of genital markings.

Something more must be said of the status of *Woodwardiella* and of *Diporochaeta*. The fact that in the present work *Perionychella* has been extended to include forms with eight setae per segment removes all justification for separating *Woodwardiella* as defined by Michaelsen from this genus. However, the Western Australian species, including the type-species, of *Woodwardiella* invariably have two pairs of spermathecae and are characterized by anterior tufted nephridia. These conditions do occur exceptionally in *Perionychella* but it seems inadvisable at present to reduce *Woodwardiella* to the status of a junior synonym in the former. The refractory state of material of *Woodwardiella* in the Western Australian Museum (Jamieson 1970) precludes thorough revision of the genus. The status of these Eastern Australian species tentatively assigned, from poor descriptions, to *Woodwardiella* requires mention. One of these, *Cryptodrilus mortoni* Spencer, 1895, is shown to be a *Perionychella* (*Vesiculodrilus*) in the present work. A second *C. tesselatus* Spencer, 1895, is almost certainly also a *Perionychella*. It has not been rediscovered in this survey. The third, *Woodwardia healesi* Michaelsen, 1923, cannot be placed with certainty in any known genus.

The type-species of *Diporochaeta*, *D. intermedia* Beddard, 1888, is exceptional in the Megascolecinae in having its last hearts in segment XI rather than in XII or XIII. This seems a normal condition in the species as it has been observed in material from several localities (Lee 1959). The fact that the ovaries are in the normal megadrile location in XIII and that spermathecae may persist in IX indicates that the unusual distribution of hearts and spermathecae is not simply due to deletion of a prespermathecal metamere. Loss of hearts from XII would be contrary to evolutionary trends in the Megascolecinae. If last hearts were in XII, *D. intermedia* might be considered congeneric with the extended *Perionychella* of the present work and, as *Diporochaeta* is the prior genus, all *Perionychella* species would have to be placed in it. Other *Diporochaeta* species in New Zealand appear from the literature to qualify for inclusion in *Perionychella* s. lat. but must be re-examined before this can be confirmed. It is here proposed to retain *Perionychella* for Australian forms conforming with the Australian type-species *Perionychella dendyi*, and to allow the heart-location in *Diporochaeta intermedia* to merit regarding this species as constituting a monotypic genus *Diporochaeta*. This restriction of *Diporochaeta* will not, however, be formally made until the status of the other New Zealand species currently in *Diporochaeta* is decided, when they may be referred to *Perionychella* or considered to warrant one or more genera distinct from both *Perionychella* and a monotypic *Diporochaeta*.

*Perionychella* accounts for almost half of the native Tasmanian earthworm species. The very profound emendation of the genus after a long period of suppression makes it desirable to list those non-Tasmanian species assignable to the genus and it will be seen that these comprise substantial components of the fauna of neighbouring Victoria.

### Subgenus ***PERIONYCHELLA*** Michaelsen, 1907a emend.

DEFINITION. As for the genus with nephridia lacking bladders.

DISTRIBUTION. As for the genus but the generic identity of the Queensland species is uncertain.

TYPE-SPECIES. *Perionychella dendyi* (Spencer, 1892b) Victoria. Syntype (?) examined, AM : W.1294.

#### CHECK LIST

*Tasmanian species*

*P.* (*P.*) *capensis* sp. n.
*P.* (*P.*) *hickmani* sp. n.
*P.* (*P.*) *kershawi* sp. n.
**Perichaeta irregularis* Spencer, 1895
*P.* (*P.*) *weldboroughi* sp. n.

*Other species*

Unless otherwise stated, material has been examined by the author as indicated.

Victoria

**Perichaeta copelandi* Spencer, 1892b Lectotype NMV : G186 ; paralectotype G1443
**Diporochaeta davallia* Spencer, 1900, *vide* Jamieson (1970)
**Perichaeta dubia* Spencer, 1892b Syntype (?) AM : W1293
*Megascolex pritchardi* Spencer, 1900, *vide* Michaelsen (1907a) and lectotype NMV : G108
**Perichaeta tanjilensis* Spencer, 1892b Syntype (?) AM : W1298

New South Wales

None known

Queensland

**Perionyx* (*Diporochaeta*) *athertonensis* Michaelsen, 1916
*Perichaeta canaliculata* Fletcher, 1888a, *vide* Michaelsen (1907b)
**Perionyx* (*Diporochaeta*) *erici* Michaelsen, 1916
**Perionyx* (*Diporochaeta*) *phalacrus* Michaelsen, 1916
**Perionyx* (?) *terrareginae* Fletcher, 1889b

* Comb. nov.

REMARKS. The condition of the nephridial ducts is not described for the Queensland species but they presumably lacked bladders as all were described by Michaelsen (1916) who in the same account described nephridial bladders for a further *Perionyx* species (*P.* (*D.*) *sigillatus*). The types are not available for examination. That these species, from the Cairns–Atherton Tableland area, should be referred to the genus *Perionychella* is nevertheless questionable. The gizzard is located more posteriorly than in Victorian and Tasmanian species, the number of setae per segment is more numerous and, although it is deduced that nephridial bladders are absent, they show affinities with *Perionyx* (*Diporochaeta*) *sigillatus* Michaelsen, 1916, from the same area, which has bladders and appears to be related to the similarly vesiculate genus *Fletcherodrilus*, rather than with *Perionychella*. Exclusion of the five north Queensland species from *Perionyx* as emended by Gates (1960) is necessitated by a set of characters of the latter genus, *viz.* female pore unpaired, midventral ; subneural vessel present ; spermathecal diverticula absent.

## Subgenus ***VESICULODRILUS*** Jamieson, 1973a

DEFINITION. As for the genus with nephridia possessing ectal bladders. (One morph of *P.* (*V.*) *mortoni* lacks bladders and their presence is questionable in the type-specimens of *P.* (*V.*) *lacustris*.)

DISTRIBUTION. As for the genus.

TYPE-SPECIES. *Cryptodrilus frenchi* Spencer, 1892a. Victoria.

### CHECK LIST

### *Tasmanian species*

*P.* (*V.*) *bithecata* sp. n.
**Perichaeta dilwynnia* Spencer, 1895
*P.* (*V.*) *evansi* sp. n.
*P.* (*V.*) *glandifera* sp. n.
*P.* (*V.*) *hellyeri* sp. n.
*Cryptodrilus hobartensis* Spencer, 1895 (new synonym *C. insularis* Spencer, 1895)
**Perionyx lacustris* Stephenson, 1924
*P.* (*V.*) *montisarthuri* sp. n.
**Cryptodrilus mortoni* Spencer, 1895
*P.* (*V.*) *obliquae* sp. n.
*P.* (*V.*) *pedderensis* sp. n.
*P.* (*V.*) *tunnackensis* sp. n.

* Comb. nov.

### *Other species*

Unless otherwise stated, material has been examined by the author as indicated.

Victoria

**Perichaeta alsophila* Spencer, 1892b Syntype (?) AM : W1297
**Diporochaeta arnoldi* Spencer, 1900 Lectotype NMV : G203
**Diporochaeta euzona* Spencer, 1900 Lectotype NMV : G120
*Cryptodrilus frenchi* Spencer, 1892*a*, *vide* Jamieson (1973a)
**Diporochaeta frosti* Spencer, 1900 Lectotype NMV : G117
*Cryptodrilus gippslandicus* Spencer, 1892a, *vide* Jamieson (1970)
**Perichaeta lochensis* Spencer, 1892a, *q.v.*
**Diporochaeta manni* Spencer, 1900 Lectotype NMV : G118
**Diporochaeta mediocincta* Spencer, 1900 Lectotype NMV : G124
**Diporochaeta richardi* Spencer, 1900 Lectotype NMV : G220
*Cryptodrilus tanjilensis* Spencer, 1892a, *vide* Jamieson (1973a) and paralectotype NMV : G55
*Megascolides tisdalli* Spencer, 1900, *vide* Jamieson (1972) and lectotype NMV : G178
*Plutellus uncinatus* Stephenson, 1933, *q.v.*
*Cryptodrilus victoriae* Spencer, 1892*a*, *vide* Jamieson (1973a) and paralectotype NMV : G1410
*Megascolides volvens* Spencer, 1900, *vide* Jamieson (1973a) and syntype (?) AM : W1292
**Cryptodrilus willsiensis* Spencer, 1892a Syntype (?) AM : W1279

New South Wales

*Vesiculodrilus frenchi* (Spencer), *vide* Jamieson (1973a)
**Diporochaeta pheretima* Jamieson, 1973a
*Vesiculodrilus purpureus* Jamieson, 1973a

Queensland

**Perichaeta barronensis* Fletcher, 1887b Syntypes (?) AM : W2387
**Diporochaeta grandis* Spencer, 1900 Lectotype NMV : G184

### Perionychella *species of uncertain subgeneric status*

The following species which are not available for re-examination accord with the above-emended definition of the genus *Perionychella* but are of uncertain subgeneric status as their authors did not record presence or absence of nephridial bladders. They are known customarily to have omitted reference to these in accounts of species since shown to possess bladders. All except *Perionychella scolecoides* (Spencer, 1895) are new combinations in *Perionychella*.

Tasmania

*Megascolides bassanus* Spencer, 1895 (King Island)
*Plutellus decatheca* Michaelsen, 1910
*Cryptodrilus ellisi* Spencer, 1895

Tasmania (cont.)

*Perichaeta moroea* Spencer, 1895
*Perichaeta richae* Spencer, 1895 (this supposedly has gizzards in III and IV, a most doubtful observation)
*Perichaeta scolecoidea* Spencer, 1895

Victoria

*Diporochaeta apiocystis* Stephenson, 1933
*Perichaeta bakeri* Fletcher, 1888b
*Perichaeta dicksonia* Spencer, 1892b
*Diporochaeta faucium* Michaelsen, 1907b
*Diporochaeta lindti* Spencer, 1900
*Diporochaeta nemoralis* Spencer, 1900
*Perichaeta obscura* Spencer, 1892b
*Diporochaeta sedecimalis* Michaelsen, 1907b
*Diporochaeta spenceri* Michaelsen, 1907b
*Diporochaeta telopea* Spencer, 1900
*Perichaeta walhallae* Spencer, 1892b

New South Wales and Queensland

*No additional species*

### KEY TO TASMANIAN SUBGENERA AND SPECIES OF *PERIONYCHELLA*

*For species of uncertain subgeneric status see specific descriptions* (*p.* 253 *et seq.*).

| | | |
|---|---|---|
| 1 | Nephridial bladders absent | subgenus ***PERIONYCHELLA***, 2 |
| – | Nephridial bladders present | subgenus ***VESICULODRILUS***, 6 |
| 2 | Setae 8 per segment throughout.* Accessory genital markings unpaired midventral or paired medianly contiguous respectively in 17/18 and 18/19. Fig. 7A | ***P. (P.) weldboroughi*** sp. n. |
| – | Setae more than 8 per segment throughout or behind the clitellum. Postclitellar genital markings not median | 3 |
| 3 | Setae 8 per segment anteriorly; numerous posteriorly. Fig. 5B | ***P. (P.) kershawi*** sp. n. |
| – | Setae more than 8 per segment throughout | 4 |
| 4 | Spermathecae 2 pairs. Fig. 5A | ***P. (P.) capensis*** sp. n. |
| – | Spermathecae 3–5 pairs | 5 |
| 5 | Spermathecae 3 pairs.† Fig. 6C | ***P. (P.) irregularis*** (Spencer, 1895) |
| – | Spermathecae 5 pairs. Fig. 6A, B | ***P. (P.) hickmanni*** sp. n. |
| 6 | Setae 8 per segment throughout | 7 |
| – | Setae more than 8 per segment throughout or at least caudally | 13 |
| 7 | Spermathecal pores 5 pairs | 8 |
| – | Spermathecal pores less than 5 pairs | 10 |
| 8 | Dorsal blood vessel bifid in the oesophageal region. A median oesophageal gland in XV. Seminal vesicles in XI and XII. Pericardiac testis-sacs present. Fig. 10A, B | ***P. (V.) glandifera*** sp. n. |

* An avesiculate morph of *P.* (*V.*) *mortoni* keys out here but differs from *weldboroughi* in having a genital field much as Fig. 12B.

† Typical specimens of *P.* (*V.*) *lacustris* with rudimentary or no bladders key out here but differ from *irregularis* in having a genital field as in Fig. 7B.

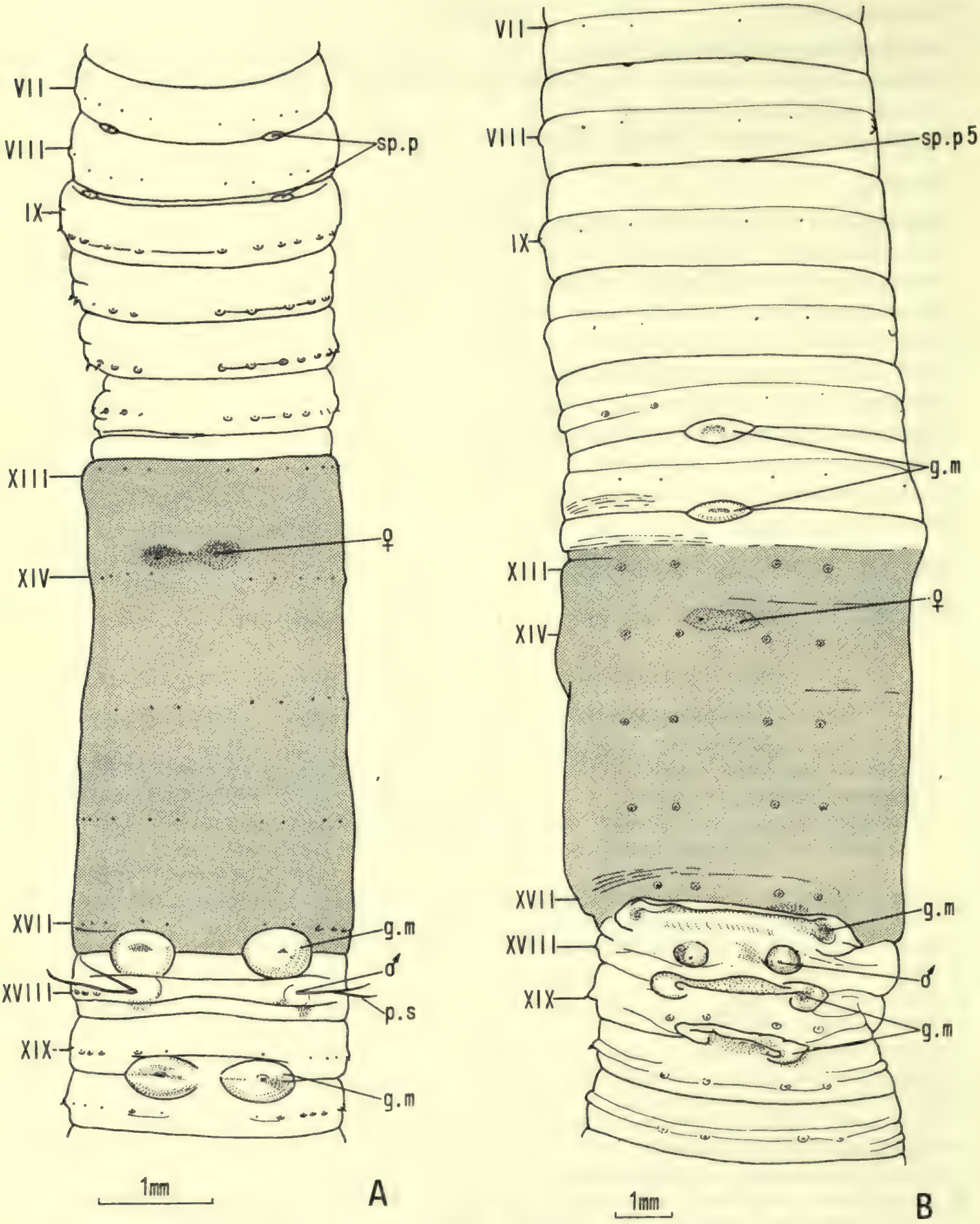

VII
VIII
IX
XIII
XIV
XVII
XVIII
XIX
sp.p
♀
g.m
♂
p.s
g.m
1mm
A
VII
VIII
IX
XIII
XIV
XVII
XVIII
XIX
sp.p5
g.m
♀
g.m
♂
g.m
1mm
B

FIG. 5. Genital fields. A, *Perionychella* (*P.*) *capensis*, holotype. B, *P.* (*P.*) *kershawi*, holotype.

Abbreviations used in figures 5–32. ♀, female pore; *g.m*, accessory genital marking; ♂, male pore; *p.s*, penial seta; *sp. p.*, spermathecal pore. Roman numerals indicate respective segments. Clitellum shaded. All figures by camera lucida.

– Dorsal blood vessel single. No extramural oesophageal glands present in XV though internal rugae may be present here and elsehwere. Seminal vesicles in IX and XII. Testis-sacs absent . . . . . . . . . . . . . 9

9 Paired accessory genital markings of the male field at the posterior borders of their segments but not intersegmental. Fig. 12B . . ***P. (V.) mortoni*** Spencer, 1895)

– Paired accessory genital markings of the male field intersegmental. Fig. 11 ***P. (V.) hobartensis*** (Spencer, 1895), part

10 Spermathecal pores 1 pair. Fig. 8A . . . . . . ***P. (V.) bithecata*** sp. n.

– Spermathecal pores 2 to 4 pairs . . . . . . . . . . . . 11

11 Spermathecal pores 2 pairs. Fig. 9A . . . . . . ***P. (V.) evansi*** sp. n.

– Spermathecal pores 3 or 4 pairs . . . . . . . . . . . . 12

12 Spermathecal pores 3 pairs. Fig. 14. . . . . ***P. (V.) tunnackensis*** sp. n.

– Spermathecal pores 4 pairs. Fig. 11. . ***P. (V.) hobartensis*** (Spencer, 1895), part

13 Setae 8 per segment in some anterior segments ; numerous posteriorly. Spermathecal pores 3 pairs . . . . . . . . . . . . . . . . 14

– Setae more than 8 per segment throughout. Spermathecal pores 3–5 pairs . . 15

14 Genital markings present in *aa* in XVII and XVIII. Fig. 9B. ***P. (V.) hellyeri*** sp. n.

– Genital markings absent in *aa*. Fig. 12A . . . ***P. (V.) montisarthuri*** sp. n.

15 Spermathecal pores 5 pairs . . . . . . . . . . . . 16

– Spermathecal pores 4 pairs or less . . . . . . . . . . . 17

16 Accessory genital markings including a midventral unpaired papilla posteriorly in each of VI and VII and anteriorly in XVIII. Fig. 8B ***P. (V.) dilwynnia*** (Spencer, 1895)

– Accessory genital markings may include a midventral papilla in VII but not elsewhere. Fig. 13A, B . . . . . . . . ***P. (V.) obliquae*** sp. n.

17 Spermathecal pores 3 pairs. Dorsal pores present. Fig. 7B ***P. (V.) lacustris*** (Stephenson, 1924)

– Spermathecal pores 4 pairs. Dorsal pores absent. Fig. 12C ***P. (V.) pedderensis*** sp. n.

## ***Perionychella (Perionychella) capensis*** sp. n.

Fig. 1, 5A, 16A, B ; Plates 91 and 92

l = 50 mm, w = 2·4, 2·5 mm, s = 108 (holotype ; paratype 1 is a posterior amputee).

Prostomium epilobous ⅔ or proepilobous. First dorsal pore 5/6. Setae in XII 22, 24 ; caudally 31, 29 or more in some segments ; ventral gap (*aa*), approximately constant, ≑ 2–3*ab* throughout ; dorsal gap (*zz*) ≑ 1–2*yz*, narrowing posteriorly but still distinct. Nephropores : preclitellar (XIII) in setal lines 6 ; intestinal in s.l. 8. Clitellum annular ½XIII–XVII. Male pores on XVIII on *b*, each with a pair of protruding, very long penial setae, on dome-shaped papillae extending from *a* to slightly median of *c*. Paired eye-like genital markings from s.l. 1 to s.l. 3 at 17/18 and from median to s.l. 1 to s.l. 2 at 19/20, that in 19/20 present on the left side only in paratype 1. Female pores paired anterior and slightly median of *a* on XIV. Spermathecal pores 2 pairs on small papillae in s.l. 3 at 7/8 and 8/9.

Last hearts in XII (latero-oesophageal). Supra-oesophageal in VIII–XIII, well developed. Gizzard vestigial, in V, an equally large but thinner walled proventriculus in IV. Extramural calciferous glands absent but oesophagus with circumferential vascular striae in VII–XV, especially dilated in XIV and XV in which, however, longitudinal rugae remain few and low. Intestinal origin ½XVI ; a very low dorsal typhlosole present (hardly appreciable).

Nephridia : simple stomate, avesiculate, exonephric holonephridia ; commencing segment indeterminable ; preseptal funnels demonstrated for those of XV posteriorly. Holandric (funnels iridescent in X and XI) ; gymnorchous ; seminal vesicles racemose, in IX and XII. Metagynous ; ovisacs present (paratype 1) or not developed (holotype). Prostates tubuloracemose, in XVIII, elongate, tongue-shaped, deeply incised, almost sessile as the duct is short ; a narrow central lumen present in the gland. Penial setae (holotype) filiform and strongly sinuous ; ectal end in profile with a group of a few small anteriorly directed spines repeated at intervals longitudinally ; tip with long, horn-shaped projections in two sequential sets of two, slightly below the pointed, asymmetrical extremity, and probably homologous with the spines ; length (right setae) 1·95, 2·74 mm. Spermathecae 2 pairs ; diverticulum (inseminated) single, digitiform, uniloculate, longer than the ampulla.

MATERIAL EXAMINED.

Table Cape, 145°45′E. 41°00′S. Map, 7/1, Dr J. L. Hickman, 24 Aug 1954 – holotype TM : K259 ; paratype 1 BM(NH) : 1972.8.3 ; paratype 2 BJ : T1.

REMARKS. *P.* (*P.*) *hickmani* is morphologically the closest species to *P.* (*P.*) *capensis* in the subgenus. Among other differences from *hickmani* are the two pairs of spermathecal pores and the genital markings in 19/20. It is also unique in the genus, in Tasmania, in possessing a typhylosole-like dorsal thickening of the intestinal wall (questionably to be considered a true typhlosole) and in location of the first dorsal pore in 5/6.

### ***Perionychella (Perionychella) hickmani*** sp. n.

Fig. 1, 6A, B, 16C, D

l = 94, 75 mm, w = 4 mm, s = 125, 112.

Prostomium epilobous ⅔, open. First dorsal pore 4/5 (rudiment in 3/4 in holotype ?). Setae in XII 24, 21 ; caudally 31, 33 ; dorsal and ventral rows (*a* and *z*) straight throughout ; ventral gap approximately 3*ab* throughout ; dorsal gap approximately 1·5 or 2*yz* anterior to clitellum ; equal to *yz* caudally. Nephropores : preclitellar pores in setal lines 6–7 ; postclitellar in setal lines 7. Clitellum annular ½XIII–½XVII, XVII. Males pores equatorial in XVIII in *ab*–*b*, on prominent papillae. Paired eye-like genital markings in 16/17, 17/18 and 18/19 in *ab*. Female pores paired on XIV, anterior and slightly median of *a*. Spermathecal pores 5 pairs, in 4/5–8/9, on small papillae in *ab*.

Last hearts in XII (latero-oesophageal). Supra-oesophageal in VIII–XIII, well developed. Gizzard large but compressible, in V. Oesophagus simple ; extramural calciferous glands absent. Intestinal origin XVIII (though pushing septum 17/18 forwards) ; typhlosole absent. Nephridia simple stomate, avesiculate, exonephric holonephridia commencing in II (preseptal funnel demonstrated in XIV but presumably present further anteriorly as nephridial morphology similar) ; tufts absent ;

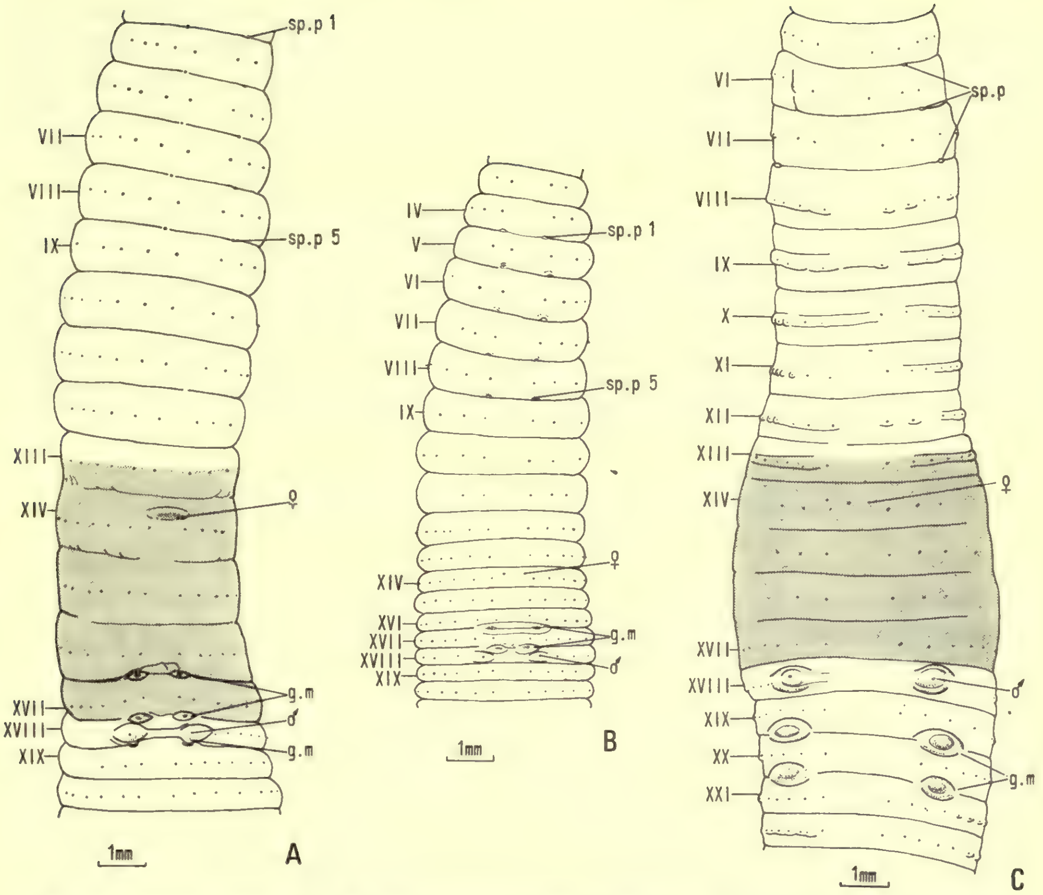

sp.p 1
VII
VIII
IX
sp.p 5
XIII
XIV
♀
g.m
XVII
XVIII
XIX
♂
g.m
1mm
A
IV
V
sp.p 1
VI
VII
VIII
sp.p 5
IX
XIV
♀
XVI
XVII
XVIII
XIX
g.m
♂
1mm
B
VI
sp.p
VII
VIII
IX
X
XI
XII
XIII
XIV
♀
XVII
XVIII
♂
XIX
XX
XXI
g.m
1mm
C

FIG. 6. Genital fields. A & B, *Perionychella* (*P.*) *hickmani* : A, holotype ; B, paratype 3. C, *P.* (*P.*) *irregularis*, lectotype.

ducts tubular, seminal vesicles racemose, in IX and XII. Metagynous ; ovisacs large, in XIV. Holandric (funnels iridescent in X and XI) ; gymnorchous. Prostates : gland almost circular, appearing to form a simple flattened lobe but resolvable into a zig-zag with narrow central lumen, the arms of which are expanded and not tubular (holotype) or depressed tubular, zig-zag in XVII–XIX (paratype 1) ; vas deferens joining ectal end of gland. Penial setae slender, almost filiform ; tip rounded, possibly worn, and with no notable sculpturing (holotype, paratype 2) or with a delicate tip hooked through about sixty degrees (paratype 3); length (right setae), 0·96, 0·85 and 1·22 mm, respectively. Spermathecae 5 pairs ; diverticulum single, clavate, uniloculate.

*Genital markings.* 7/3 – paratype 2 agreeing exactly with holotype and paratype 1 ; 13/5 – paratypes 3 and 4, mature specimens as holotype but lacking accessory genital markings in 18/19.

*Other variation.* The two mature paratypes from Lake St Clair agree closely in morphology with the holotype, differing in the following unimportant respects: l = 47–49 mm; s = 105–108; the prostomium is closed; the setal count rises to 46 caudally; the nephridia of II are astomate rudiments, those of III having demonstrable funnels (see also *Genital markings*).

MATERIAL EXAMINED.

Fern Glade, Emu River, Burnie, 145°55′E. 41°05′S. Map, 7/2, Dr J. L. Hickman, 24 Aug 1954 – holotype TM: K260. Hellyer Gorge, 145°35′E. 41°20′S. Map, 7/3, Dr J. L. Hickman, 28 May 1954 – paratype 1 BM(NH): 1972.8.12. Parrawe, 145°35′E. 41°20′S. Map, 7/3, Dr J. L. Hickman, 25 Aug 1954 – paratype 2 TM: K261. Lake St Clair, 146°10′E. 42°05′S. Map, 13/5, Dr J. W. Evans, Feb 1941 – paratypes 3 and 4 BM(NH): 1972.8.13–14; paratype 5 AM: W5185.

REMARKS. Differences between this species and *P.* (*P.*) *capensis*, which is closest to it morphologically, are given under the latter species.

## ***Perionychella (Perionychella) irregularis*** (Spencer, 1895)

Fig. 1, 6C

*Perichaeta irregularis* Spencer, 1895: 53–54, Pl. V, fig. 52–54.
*Diporochaeta irregularis*; Michaelsen, 1900: 206; Jamieson, 1971b: 83.

l = 87 mm, w = 4·7 mm, s = 104.

Prostomium canaliculate, epilobous ½. First dorsal pore in 4/5. Setae 11 on each side in V, 15–16 on each side in XII and onto the midbody; 20 on each side caudally; ventral and dorsal setal gaps conspicuous throughout; in XII *aa* ≑ 2*ab*, *zz* ≑ 3*zy*; in the midbody and caudally *aa* ≑ 3*ab*, *zz* ≑ 4*zy*. Nephropores between setal lines 8 and 9. Clitellum annular, ½XIII–XVII and, dorsally, anterior XVIII; setae, intersegments (weaker) and dorsal pores retained. Male pores on prominent elliptical papillae between setal lines 2 and 3, nearer 2, on XVIII, the intervening setal rows not demonstrably bearing setae in this segment. Two pairs of eye-like accessory genital markings in (or, lectotype, immediately median to) setal lines 3, in 19/20 and 20/21. Female pores in XIV, anteromedian of *a*, near the ventral midline. Spermathecal pores 3 pairs, in 6/7, 7/8 and 8/9, in setal lines 3, 4 and 5 respectively (Spencer) but only slightly divergent posteriorly.

Dorsal blood vessel single, continuous onto the pharynx. Last hearts in XII (latero-oesophageal but lacking dorsal connectives). Supra-oesophageal weakly developed, in X–XII. Gizzard small, with pronounced muscular sheen but easily compressed, appearing to lie in VI but the very attenuated septum 5/6 adherent to it slightly behind its anterior limit, suggesting that the gizzard has moved from V into VI by adhesion of the attenuated septum. Calciferous glands absent but oesophagus vascularized in VIII–XVI and swollen in some of these. Intestinal origin XVII; typhlosole absent. Nephridia stomate avesiculate holonephridia, commencing in II (funnels demonstrated from XVIII); tufted nephridia absent. Holandric (funnels iridescent in X and XI); seminal vesicles 4 pairs, small and simple in IX and X, large and racemose in XI and XII. Metagynous; small ovisacs in XIV.

Prostates depressed, linear, laterally deeply incised, in XVII–XXII, resolvable with difficulty into a tubular form ; external muscular duct very long and tortuous. Penial setae absent. Spermathecae 3 pairs, not notably departing from a line parallel with the body axis ; diverticulum (inseminated) single, clavate, uniloculate.

TYPE-LOCALITY. King River Valley, approximately 145°25′E. 42°10′S. Map, 12/1.

MATERIAL EXAMINED.

The previously dissected lectotype, NMV : G288.

REMARKS. The above account considerably augments that of Spencer and demonstrates the avesiculate condition of the nephridial ducts for the first time. The dimensions accord with the specimen described by Spencer.

Closest to this species are the similarly perichaetine species *P.* (*P.*) *hickmani* and *P.* (*P.*) *capensis*. It differs from both in having three pairs of spermathecal pores and in lacking genital markings anterior to the male pores.

### ***Perionychella (Perionychella) kershawi*** sp. n.

Fig. 1, 5B, 16E. Table 2

l = 171 mm, w = 6·1 mm, s = 119.

Prostomium epilobous $\frac{1}{3}$, closed with a grooved peristomium giving a tanylobous appearance. First dorsal pore 4/5. Setae 8 per segment anterior to clitellum ; posterior to clitellum occasionally with an extra seta in *cd* ; in the posterior half, setae at first added in the dorsal gap, caudally the rows becoming irregular and approximately 21 seta per segment. Nephropores in *c* lines anteriorly ; visible posteriorly but setal lines irregular. Clitellum annular, XIII–XVII. Male pores on small dome-shaped papillae in *a* on XVIII. Small eye-like unpaired midventral accessory genital markings in 11/12 and 12/13 ; paired transversely conjoined markings, extending lateral of mid *bc* at 17/18, extending shortly lateral of *b* at 18/19 and occupying *bb* at 19/20. Female pores a pair in XIV, anteromedian of ***a***. Spermathecal pores 5 pairs in 4/5–8/9, on small papillae in ***a***.

Last hearts in XII, latero-oesophageal, connectives to dorsal vessels very slender, thread-like. Supra-oesophageal weak in VII, well developed in VIII–XII. Gizzard very large but easily compressible in V. Extramural calciferous glands absent. Oesophagus with engorged circumferential vascular striae in VIII–XV ; in (XIII ?), XIV and XV strongly dilated and with longitudinal striations which correspond with low internal ridges (severely macerated in this region) which suggest some (calciferous ?) modification. Intestinal origin XVII ; typhlosole absent. Nephridia tufted holonephridia in II–IX, with posteriorly decreasing numbers of coiled loops, discharging presetally in *c* lines ; stomate at least from X in which coiling in insufficient to be termed tufted, but anterior tufted nephridia probably are also stomate as a slender neck is demonstrable to the anterior septum. Bladders absent unless terminal dilatations of the ducts of the anterior tufts be considered vestigial bladders.

Holandric (funnels iridescent in X and XI) ; gymnorchous ; seminal vesicles racemose, in IX and XII. Presence of ovaries or ovisacs indeterminable owing to maceration. Prostates slender coiled only slightly depressed tubes, winding through XVII–XXIV; vas deferens joining the gland near the junction of the sinuous duct. Penial setae present, form not elucidated; length (holotype) 2·25, 2·37, 2·39 mm. Spermathecae 5 pairs; diverticulum (inseminated) single, clavate, uniloculate.

MATERIAL EXAMINED.

Under a rotting log near the old Breiseis Tin Mine dam, Derby, 147°50′E. 41°10′S. Map, 9/4, Mr R. C. Kershaw, 19 Sep 1971 – holotype TM : 262.

REMARKS. This species differs from other Tasmanian species of the sugbenus in having midventral genital markings in 11/12 and 12/13 and in transition of the setae from 8 per segment anteriorly to many posteriorly.

TABLE 2

Mean intersetal distances in segment XII in lumbricine species of *Perionychella* (*Perionychella* and *Vesiculodrilus*)

| | no. of | | standardized to a periphery of 100 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | specimens | *aa* | *ab* | *bc* | *cd* | *dd* | *dc* | *cb* | *ba* |
| *P.* (*P.*) *kershawi* | (1) | 12·65 | 5·14 | 11·46 | 10·28 | 33·2 | 9·88 | 12·25 | 5·14 |
| *P.* (*P.*) *weldboroughi* | (1) | 11·57 | 4·96 | 9·92 | 9·92 | 38·84 | 9·92 | 9·92 | 4·96 |
| *P.* (*V.*) *bithecata* | (5) | 12·1 | 7·87 | 12·45 | 12·76 | 21·53 | 13·25 | 12·12 | 7·87 |
| *P.* (*V.*) *evansi* | (2) | 10·35 | 7·71 | 14·28 | 12·98 | 20·09 | 12·98 | 13·9 | 7·71 |
| *P.* (*V.*) *glandifera* | (2) | 9·89 | 4·94 | 18·39 | 8·34 | 27·44 | 8·18 | 17·37 | 5·46 |
| *P.* (*V.*) *hellyeri* | (5) | 12·42 | 8·17 | 12·82 | 12·51 | 20·70 | 12·62 | 12·76 | 8·00 |
| *P.* (*V.*) *hobartensis* | (12) | 11·59 | 7·16 | 13·22 | 13·0 | 21·98 | 12·87 | 13·2 | 6·94 |
| *P.* (*V.*) *montisarthuri* | (1) | 12·5 | 8·8 | 11·11 | 14·81 | 17·59 | 15·74 | 11·57 | 7·87 |
| *P.* (*V.*) *mortoni* | (3) | 11·83 | 6·83 | 15·89 | 11·4 | 19·87 | 11·74 | 15·79 | 6·64 |
| *P.* (*V.*) *tunnackensis* | (1) | 11·74 | 7·04 | 13·15 | 14·08 | 19·72 | 14·08 | 13·15 | 7·04 |

| | no. of | | | | intervals/*ab* | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | specimens | *aa* | *ab* | *bc* | *cd* | *dd* | *dc* | *cb* | *ba* |
| *P.* (*P.*) *kershawi* | (1) | 2·44 | 1·00 | 2·23 | 2·00 | 6·46 | 1·92 | 2·38 | 1·00 |
| *P.* (*P.*) *weldboroughi* | (1) | 2·33 | 1·00 | 2·00 | 2·00 | 7·83 | 2·00 | 2·00 | 1·00 |
| *P.* (*V.*) *bithecata* | (5) | 1·54 | 1·00 | 1·58 | 1·62 | 2·74 | 1·68 | 1·54 | 1·00 |
| *P.* (*V.*) *evansi* | (2) | 1·34 | 1·00 | 1·85 | 1·68 | 2·61 | 1·68 | 1·80 | 1·00 |
| *P.* (*V.*) *glandifera* | (2) | 2·00 | 1·00 | 3·72 | 1·69 | 5·55 | 1·66 | 3·52 | 1·10 |
| *P.* (*V.*) *hellyeri* | (5) | 1·52 | 1·00 | 1·57 | 1·53 | 2·53 | 1·54 | 1·56 | 0·98 |
| *P.* (*V.*) *hobartensis* | (12) | 1·62 | 1·00 | 1·85 | 1·82 | 3·07 | 1·8 | 1·84 | 0·97 |
| *P.* (*V.*) *montisarthuri* | (1) | 1·42 | 1·00 | 1·26 | 1·68 | 2·00 | 1·79 | 1·31 | 0·89 |
| *P.* (*V.*) *mortoni* | (3) | 1·73 | 1·00 | 2·33 | 1·67 | 2·91 | 1·72 | 2·31 | 0·97 |
| *P.* (*V.*) *tunnackensis* | (1) | 1·67 | 1·00 | 1·87 | 2·00 | 2·80 | 2·00 | 1·87 | 1·00 |

## ***Perionychella (Perionychella) weldboroughi*** sp. n.

Fig. 1, 7A, 16F. Table 2

l = 48 mm, w = 1·6 mm, s = 71.

Prostomium tanylobous. First dorsal pore 4/5. Setae 8 per segment in regular longitudinal rows throughout. Nephropores faint in *c* lines. Clitellum annular

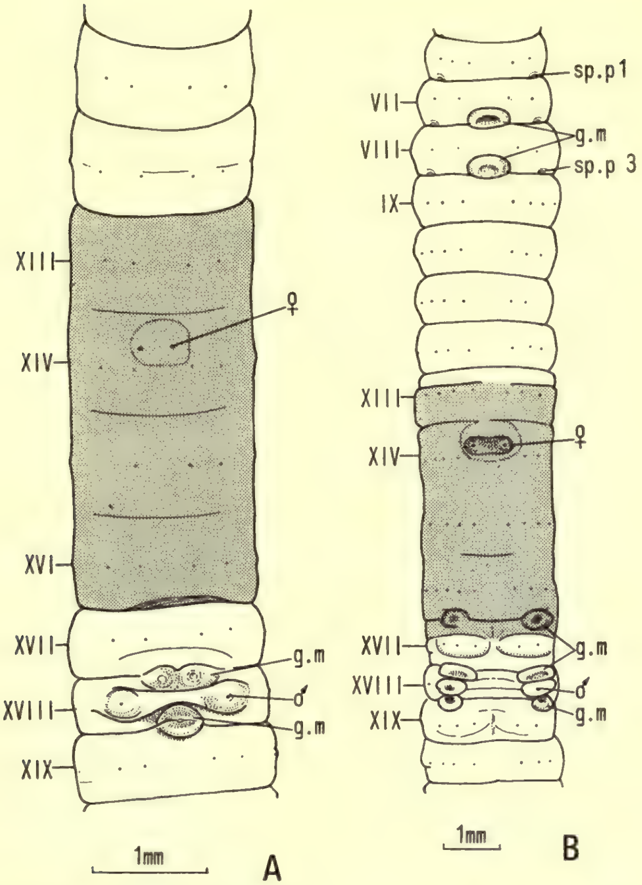


FIG. 7. Genital fields. A, *Perionychella* (*P.*) *weldboroughi*, holotype. B, *P.* (*V.*) *lacustris*, TM : K265.

XIII–XVI. Male pores equatorial in XVIII, on pronounced papillae in *ab* with centres nearer *b* than *a* ; preceded by a pair of medianly contiguous small papillae in *aa* at 17/18, with a further midventral unpaired papilla at 18/19. Faint traces of presetal midventral unpaired markings present in VII ?, VIII ? and IX. Female pores a pair on XIV anterior to and slightly median of *a*. Spermathecal pores 5 pairs in 4/5–8/9 in or slightly lateral of *a*.

Last hearts in XII. Supra-oesophageal very weakly developed. Gizzard moderate, but easily compressible, in V. Calciferous glands absent but oesophagus greatly dilated in XIII–XV in which vascularization is increased and internal longitudinal rugae, though low, are conspicuous. Intestinal origin XVII ; typhlosole absent but intestinal wall slightly thicker middorsally. Nephridia simple stomate avesiculate holonephridia commencing in II (funnels demonstrated in the intestinal region) ; ectal ducts lacking bladders. Holandric (funnels in X and XI iridescent) ; gymnorchous ; seminal vesicles very large, racemose, in IX and XII. Metagynous ;

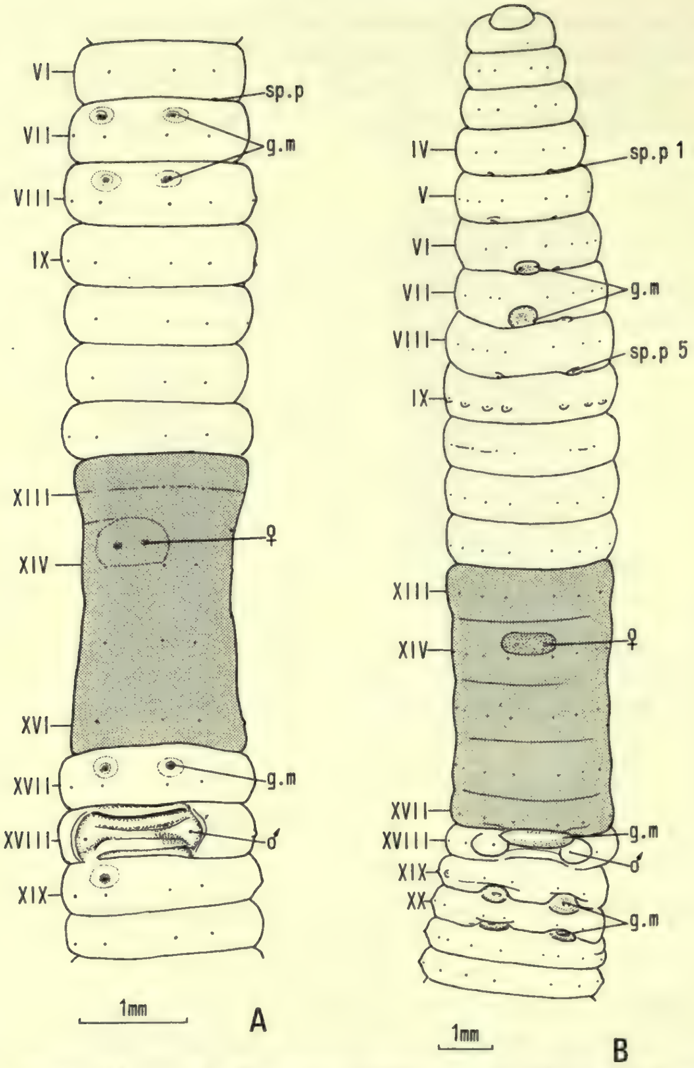

VI
sp.p
VII
g.m
VIII
IX
XIII
♀
XIV
XVI
XVII
g.m
XVIII
♂
XIX
1mm
A
IV
sp.p 1
V
VI
g.m
VII
VIII
sp.p 5
IX
XIII
♀
XIV
XVII
g.m
XVIII
♂
XIX
XX
g.m
1mm
B

FIG. 8. Genital fields. A, *Perionychella* (*Vesiculodrilus*) *bithecata*, holotype. B, *P.* (*V.*) *dilwynnia*, TM : K266.

ovisacs small, in XIV. Prostates flattened, somewhat incised, tubular, in XVIII–XX; vas deferens joining gland near the tortuous duct. Penial setae (holotype) filiform and sinuous, lacking ornamentation but tip apparently missing; length (incomplete ?) = 0·42 mm. Spermathecae 5 pairs, diverticulum single, slenderly clavate, uniloculate.

MATERIAL EXAMINED.

1·6 miles from the eastern end of Weldborough Pass, 147°55′E. 41°10′S. Map, 9/3, Dr J. L. Hickman, 26 Aug 1953 – holotype TM : K263.

REMARKS. The midventral genital marking in 18/19 diagnoses this species.

## ***Perionychella (Vesiculodrilus) bithecata*** sp. n.

Fig. 1, 8A, 16H; Plate 93. Table 2

l = 41, 35 mm, w = 1·5 mm, s = 93, 98.

Prostomium epilobous $\frac{1}{2}$ open. First dorsal pore 4/5. Setae 8 per segment in regular longitudinal rows throughout. Nephropores in *c* lines. Clitellum annular $\frac{1}{2}$XIII–XVI. Male pores equatorial in XVIII in *ab* on small medianly conjoined papillae; 2 transverse tumid bands spanning the space between the porophores, one anteriorly the other posteriorly in XVIII, each band traversed by a groove which is parallel to but distinct from the intersegmental furrows. Genital markings; 3 pairs of eye-like markings anterior to *a* in VII, VIII and XVII and on the right side only in XIX (holotype); these replaced in paratype 1 by paired markings in *ab*, posteriorly in VI and XVII. Female pores a pair on XIV anteromedian to *a* surrounded by a nonpigmented oval marking filling *aa*. Spermathecal pores 1 pair, in 6/7, in *b*.

Last hearts in XII (latero-oesophageal). Supra-oesophageal moderately developed. Gizzard small to moderate, easily compressible, in V. Calciferous glands absent; oesophagus widest in XIV and XV in which internally it has large, regular longitudinal folds; intestinal origin XVII; typhlosole absent. Nephridia simple stomate, vesiculate, exonephric holonephridia commencing in II (funnels demonstrated at least as far forward as the nephridia of III); bladder transversely ellipsoid and projecting median of the pore (in *c* line) through not truly diverticulate. Holandric (funnels iridescent in X and XI); gymnorchous; seminal vesicles racemose in IX and XII. Metagynous; ovisacs small in XIV. Prostates depressed tubular, compacted coils in XVII–XXI; Penial setae (paratypes 1, 3) filiform and sinuous; tip inrolled, hooked and with a pair of 'dorsal', short horns visible only under the electron microscope; length (paratype 1) 0·39 mm. Spermathecae 1 pair, with pores in 6/7; the ampulla extending into IX or VIII; diverticulum (inseminated) single, uniloculate, bent clavate.

Genital markings in the holotype and 3 paratypes

| | Specimen | | Total number of specimens |
|---|---|---|---|
| Paired posterior in VI in *ab* | – | P1. P3(R) | 2 |
| Paired presetal in VII in *a* | H | – | 1 |
| Paired presetal in VIII in *a* | H | – | 1 |
| Paired presetal in XVII in *a* | H | – | 1 |
| Paired posterior in XVII in *ab* | – | P1, 2. P3(R) | 3 |
| Unilateral (R) in 18/19 in *ab* | – | P2 | 1 |
| Unilateral presetal in XIX in *a* (R) | H | – | 1 |
| or *ab* (L) | – | P3 | 1 |

H = Holotype; P = Paratypes. R = right. L = left.

### MATERIAL EXAMINED.

Hellyer Gorge, 145°35′E. 41°20′S. Map, 7/3, Dr J. L. Hickman, 28 May 1954 – holotype TM: K264; paratype 1 BM(NH): 1972.8.1; paratypes 2, 3 AM: W5186–7: paratype 4 BJ: T2.

REMARKS. The configuration of genital markings in the paratypes differs markedly from that in the holotype but similarity of general morphology, including the bithecal condition (which is unique in the genus), indicates conspecificity.

## *Perionychella (Vesiculodrilus) dilwynnia* (Spencer, 1895)

Fig. 1, 8B, 16J ; Plates 94–96

*Perichaeta dilwynnia* Spencer, 1895 : 50–51, Pl. IV, fig. 46–48.
*Diporochaeta dilwynnia* ; Michaelsen, 1900 : 204 ; Jamieson 1971b : 83.

l = 71, 52 mm, w = 3·0, 2·6 mm, s = 104, 118 (Specimens 1 and 2 respectively, throughout account).

Prostomium epilobous ½, open, but deep dorsal canalicula extending to intersegment 1/2. Peristomium similarly grooved midventrally. First dorsal pore 4/5. Caudal end dorsoventrally depressed. Setae in XII, 16, 14 ; caudally 24 per segment ; dorsal and ventral rows (*a* and *z*) straight throughout but caudally some setae of *z* line are omitted ; ventral gap approximately 2*ab* throughout ; dorsal gap inconstant even over a few segments, usually a definite interruption of the setal circlet but not more than twice the general *zy* width. Nephropores : preclitellar in setal lines 4–5 ; postclitellar in 4 ; caudally in 6–7 ; in a straight lateral row on each side. Clitellum annular, XIII, ½XIII–XVII. Male pores equatorial in XVIII in mid *ab*, on large prominent papillae ; a transversely elongate elliptical papilla filling the space between them in the anterior half of the segment. Paired eye-like genital markings in 19/20 and 20/21 in *ab* and an unpaired postsetal midventral marking in each of VI and VII. Female pores shortly anteromedian to setae *a* of XIV. Spermathecal pores 5 pairs, on small papillae in 4/5–8/9, in *ab*.

Last hearts in XII (latero-oesophageal). Supra-oesophageal well developed in IX–XII, weak in VIII and XIII. Gizzard small, almost rudimentary, in V. Oesophagus simple, extramural calciferous glands absent. Intestinal origin XVII ; typhlosole absent. Nephridia simple stomate, exonephric, vesiculate holonephridia throughout, commencing in II ; each with large, single preseptal funnel and long, wide, tortuous tubular bladder. Holandric (funnels iridescent) ; gymnorchous ; seminal vesicles racemose, in IX and XII. Metagynous ; ovisacs in XIV. Prostates depressed, lobulated tubular, with compressed coils, in XVII–XX (1), XVIII only (2) ; vas deferens joining junction of gland and duct. Penial setae (specimens 1 and 2) slender, needle-like, not filiform ; tip pointed, asymmetrical, convex on one side, straight or slightly concave on the other ; ornamentation in profile consisting of alternating V-shaped depressions the border of which, at the angle, projects towards the apex of the seta as an irregular scale ; length (specimen 1) = 0·77 mm. Spermathecae 5 pairs ; diverticulum (inseminated) single, clavate, uniloculate.

*Genital markings.* 13/4 – (specimens 1–9) median genital marking in VI absent in specimens 3–6, 8 ; otherwise agreeing in all respects with specimen 1.

TYPE-LOCALITY. Dee Bridge, 146°35′E. 42°15′S. Map, 13/7.

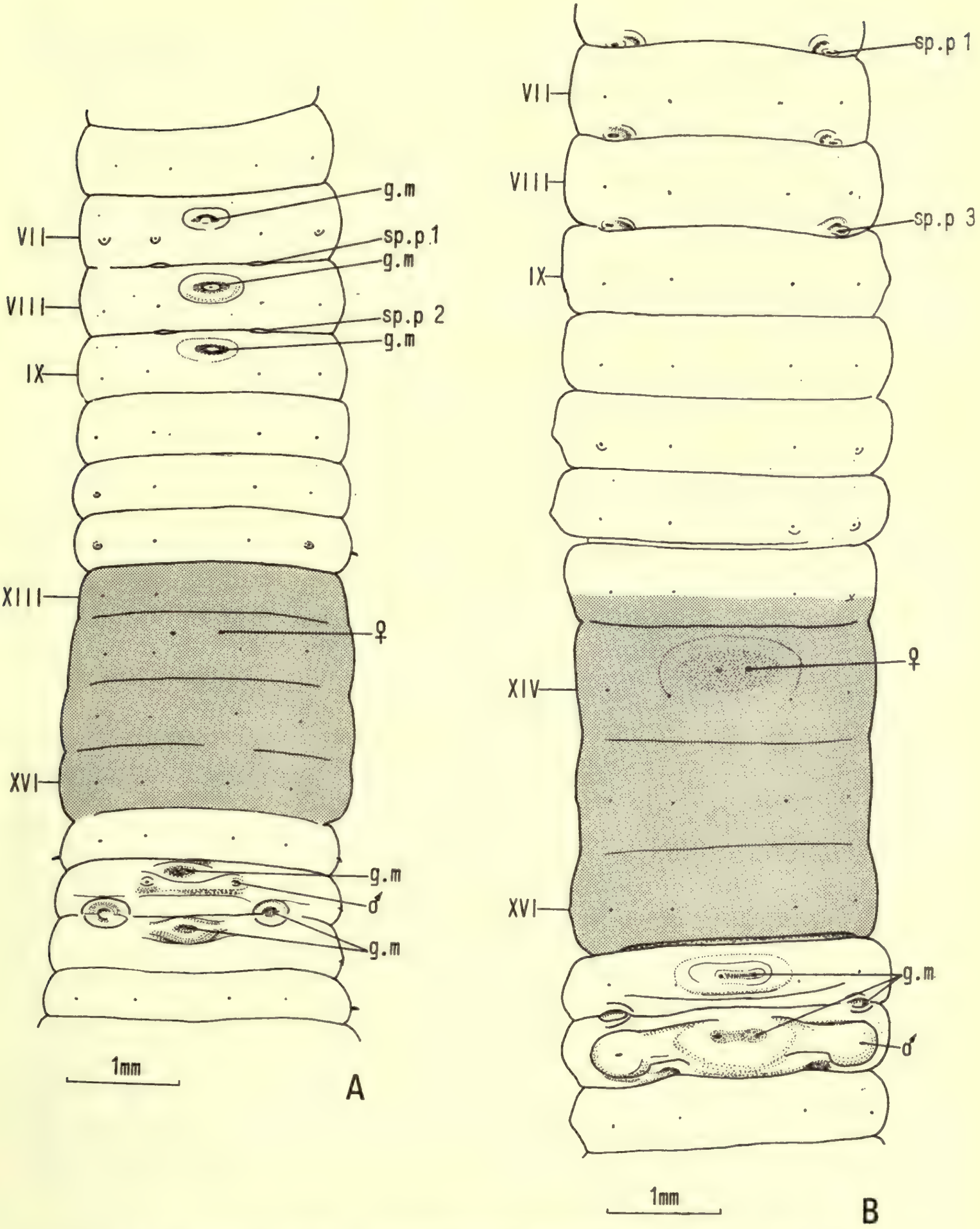

g.m
VII
sp.p 1
g.m
VIII
sp.p 2
g.m
IX
XIII
♀
XVI
g.m
♂
g.m
1mm
A
sp.p 1
VII
VIII
sp.p 3
IX
♀
XIV
XVI
g.m
♂
1mm
B

FIG. 9. Genital fields. A, *Perionychella* (*Vesiculodrilus*) *evansi*, holotype. B, *P.* (*V.*) *hellyeri*, holotype.

MATERIAL EXAMINED.

Tarraleah, 146°25′E. 42°20′S. Map, 13/4, over pipeline, Dr J. L. Hickman, 27 May 1954 – specimens 1–9 TM : K266–274 ; specimens 10–13 BM(NH) : 1972.8.4–7 ; Butlers Gorge Road, 1·4 miles from Tarraleah, Dr J. L. Hickman, 27 May 1954 – specimens 14–20 TM : K275–281 ; specimens 21–32 BJ : T3–14 ; Tarraleah, Lyell Highway, Dr J. L. Hickman, 22 May 1954 – specimens 33–36 AM : W5188–5191.

REMARKS. The new material was collected a few miles from the Dee Bridge type-locality. The type-specimens are lost (Jensz and Smith 1969). It appears from Spencer's description that they differed from the Tarraleah specimens in clitellar extent (XIV–XVII) ; in location of the paired genital markings in 18/19 and 19/20 and absence of the midventral markings in VI and VII ; the median marking in XVIII was present and setal counts agreed closely. Nephridial bladders were not mentioned.

### ***Perionychella (Vesiculodrilus) evansi*** sp. n.

Fig. 1, 9A, 15C, 16K. Table 2

l = 51 (?) mm (the paratype damaged anteriorly), w = 2·6, 2·5 mm, s = 102, 117.

Prostomium epilobous ⅔, closed ; first dorsal pore (2/3 ?), 3/4 (holotype). Setae in 8 regular longitudinal rows throughout. Nephropores in *c* lines. Clitellum annular, XIII–XVI. Male pores on small papillae in *a* on XVIII. Five transversely elliptical, unpaired, midventral genital markings in the anterior half of VII, VIII, IX, XVIII and XIX (holotype), that in IX absent in paratype, and a pair of eye-like markings at 18/19 with centres in *b* (both specimens). Female pores a pair in XIV anteromedian of *a*. Spermathecal pores 2 pairs in 7/8 and 8/9, in *a*.

Last hearts in XII (latero-oesophageal). Supra-oesophageal well developed. Gizzard in V (damaged and not recognizable in paratype), moderately large but fairly easily compressible. Calciferous glands absent but oesophagus internally rugose in VI–XV, especially so in XIV and XV in which it is conspicuously dilated, but lacking specialized internal lamellae. Intestinal origin XVI ; typhlosole absent. Nephridia simple stomate vesiculate exonephric holonephridia ; first seen in III but pores apparently commencing anteriorly in II ; funnels present at least as far forward as VII ; the bladders at first pyriform but by IX becoming distinctly bilobed, the ectal nephridial duct joining the median lobe. Holandric (funnels very large, only those in X iridescent in the holotype, iridescent in XI also in the paratype) ; seminal vesicles racemose, in IX and XII. Metagynous ; ovisacs very large, multiloculate, in XIV (holotype ; not demonstrable in paratype). Prostates appearing racemose, in XVII–XX, XXI but resolvable into a compressed and minutely lobulated tubular form. Penial setae (holotype) needle like, not filiform ; tip smooth and rounded ; ornamentation absent, length = 0·71 mm. Spermathecae 2 pairs ; diverticulum (inseminated) single, clavate, uniloculate.

MATERIAL EXAMINED.

Lake St Clair, 146°10′E. 42°05′S. Map, 13/5, Dr J. W. Evans, Feb 1941 – holotype TM : K282. Same locality, Tasmanian Biological Survey : J20, Feb 1941 – paratype BM(NH) : 1972.8.8.

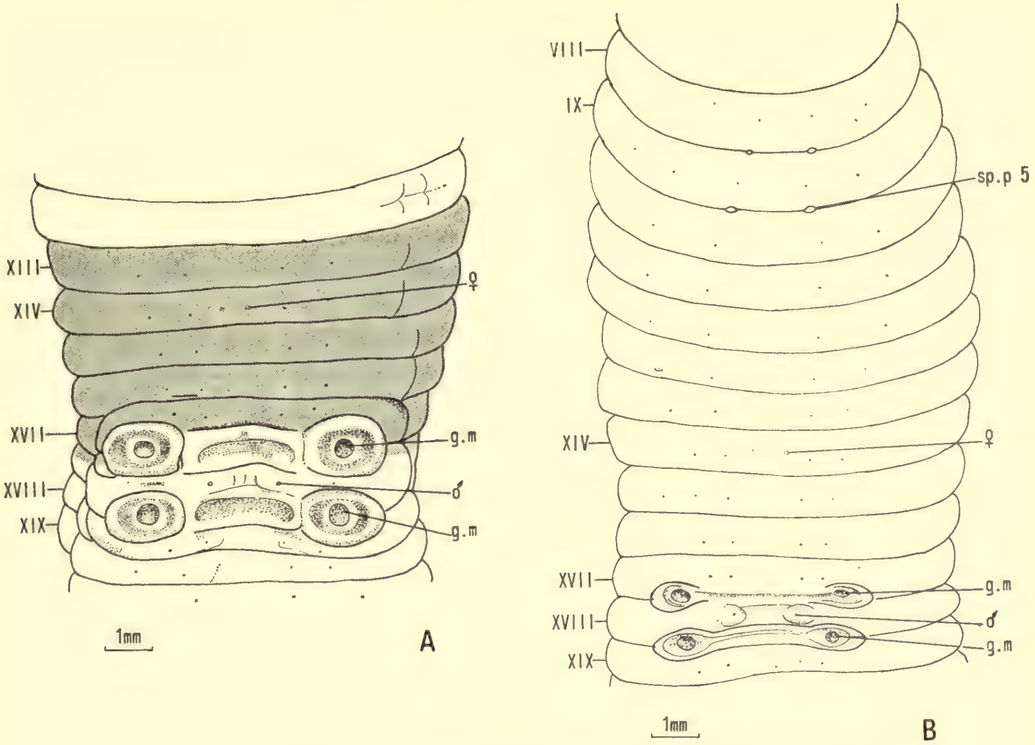


FIG. 10. Genital fields. *Perionychella* (*Vesiculodrilus*) *glandifera* : A, holotype ; B, paratype.

REMARKS. This species appears to be closest morphologically to *P.* (*V.*) *lacustris*. Some differences from the latter are the lumbricine setae, the two pairs of spermathecal pores, the presetal rather than postsetal location of the anterior genital markings and the configuration of those of the male genital field.

### ***Perionychella (Vesiculodrilus) glandifera*** sp. n.

Fig. 1, 10A, B, 15D, 16L, M. Table 2

l = 75, 73 mm, w = 6·5, 7·5 mm, s = 98.

Prostomium canaliculate, broadly tanylobous. Body rectangular in cross section. First dorsal pore 3/4 (imperforate ? holotype), 4/5 perforate. Setae 8 per segment in regular longitudinal rows throughout. Nephropores in *c* lines. Clitellum annular, XIII–¼XVIII (holotype ; the paratype is aclitellate). Male pores equatorial in *a* lines of XVIII on weakly developed papillae on the setal ridge ; 2 pairs of large sucker-like genital markings with pore-like centres in intersegments 17/18 and 18/19, the centres lateral to *b* lines, each marking spanning the distance between the setal arcs of adjacent segments ; a transverse glandular depression linking each marking with that of the other side (holotype). Two pairs of eye-like transversely conjoined markings shortly lateral of *b* at 17/18 and 18/19 in paratype. Female pores shortly anterior to the setal arc of XIV at 1/3 *aa*. Spermathecal pores minute, 5 pairs in 4/5–8/9 in *a* lines.

Dorsal vessel segmentally bifid in VIII (paratype), IX (holotype)–XVIII; last hearts in XII (latero-oesophageal). Supra-oesophageal weakly developed. Gizzard large, in V but extending well posteriorly. Oesophagus in XV expanded to form a subspherical unpaired calciferous gland with many closely packed internal radial laminae which fill the oesophageal lumen but do not unite centrally. Intestinal origin ½XVII (paratype) or posterior XVII (holotype); typhlosole absent. Nephridia vesiculate, exonephric holonephridia discharging by large bladders throughout, commencing in II (holotype); those in II forming small tufts and lacking detectable funnels (no nephridia detectable in II in paratype); the remaining nephridia simple and each with a preseptal funnel; bladders in the anterior segments very long, wide tortuous tubes; in VI (holotype) or somewhat more posteriorly (paratype) the bladder is bent near its ectal end and the bend is drawn out slightly as a diverticulum; succeeding bladders are increasingly diverticulate; full development of the diverticulum as a long lateral digitiform process is attained by segment XIX and is maintained to the caudal extremity although caudal nephridia are smaller than those in the anterior region. Holandric (funnels iridescent); cleistorchous, pericardiac testis-sacs formed by longitudinal fusion of septa 9/10, 10/11 and 11/12; seminal vesicles racemose in XI (in the testis-sac) and XII (free). Metagynous. Ovisacs absent (holotype) or present in XIV (paratype). Prostates depressed tubular, compactly coiled, in XVIII–XX (holotype); restricted to XVIII and not fully developed in paratype; vas deferens joining ectal end of gland (holotype); penial setae absent. Spermathecae 5 pairs; diverticulum (inseminated only in holotype) single, clavate, uniloculate.

MATERIAL EXAMINED.

St Helens, on road to Launceston via Scottsdale between 94 and 96 mile posts, 148°15′E. 41°20′S. Map, 10/2, Dr J. L. Hickman, 26 Aug 1953 – holotype TM: K283. St Columba Falls, 147°55′E. 41°20′S. Map, 9/2, Dr J. L. Hickman, 17 Apr 1954 – paratype BM(NH): 1972.8.9.

REMARKS. *Perionychella* (*V.*) *glandifera* is unique among the known Tasmanian species of the genus in the bifid dorsal vessel, the extramural oesophageal gland in XV, in possessing testis-sacs and in location of the seminal vesicles in XI and XII.

### ***Perionychella (Vesiculodrilus) hellyeri*** sp. n.

Fig. 1, 9B, 16N, O. Table 2

l = 54, 62 mm, w = 2·6, 3·0 mm, s = 104, 97.

Prostomium indistinctly epilobous ½, open. First dorsal pore 4/5. Setae 8 per segment, the rows becoming irregular in the posterior 12 or 40 segments in which there are 20–24 setae per segment. Nephropores in *c* lines. Clitellum annular, ½XIII–XVI. Male pores on prominent rounded papillae, equatorial in XVIII, in *b*;

the papillae transversely conjoined by a midventral boss which bears presetally two widely conjoined pore-like markings, a similar boss present with conjoined presetal markings on XVII ; a pair of eye-like genital markings present in 17/18 in *b* lines (holotype) ; presetal markings absent from XVII in paratype 1 and the median boss in XVIII replaced with 2 small circular markings in *aa* joined to the male papillae by slight ridges ; eye-like markings present in 17/18. Two pairs of eye-like markings presetally in *b*, on IX and X in paratype 1 ; absent in holotype. Female pores paired, on XIV, anteromedian of *a*. Spermathecal pores 3 pairs, in 6/7–8/9, in *b*, on small papillae each of which is preceded by a lip-like prominence (holotype, paratypes 1–5).

Last hearts in XII (latero-oesophageal). Supra-oesophageal in VIII–XIII, well developed. Gizzard vestigial (questionably present), in V. Extramural calciferous glands absent but oesophagus enlarged and vascularized with lamellar internal rugae in XIV and XV. Intestinal origin XVII ; typhlosole absent. Nephridia simple, vesiculate exonephric holonephridia ; preseptal funnel demonstrated in those of III ; possibly rudimentary nephridia in II ; bladder large, subspherical to transversely elliptical, the lateral extremity protuberant and almost forming a diverticulum. Holandric (gymnorchous) or probably incipiently metandric ; only posterior funnels iridescent and seminal vesicles large in XII but vestigial in IX (holotype) ; male organs of IX and X completely absent in paratypes 1 and 2 (metandric). Metagynous ; ovisacs in XIV. Prostates flattened tubular, with lobulated, compacted coils in XVIII–XX, XXI. Penial setae (paratype 1) moderately stout, not filiform, but ectal region sigmoid ; tip simple ; ectally weakly ornamented with anteriorly directed ∧-shaped scales flush with the surface and commonly in triads ; the tip of a reserve seta (paratype 5) has a delicate, hooked extremity ; length of a well-developed seta (paratypes 2 and 5) = 1·18, 1·00 mm. Spermathecae 3 pairs ; diverticulum (inseminated) single, clavate, uniloculate.

Genital markings of the holotype and 5 paratypes

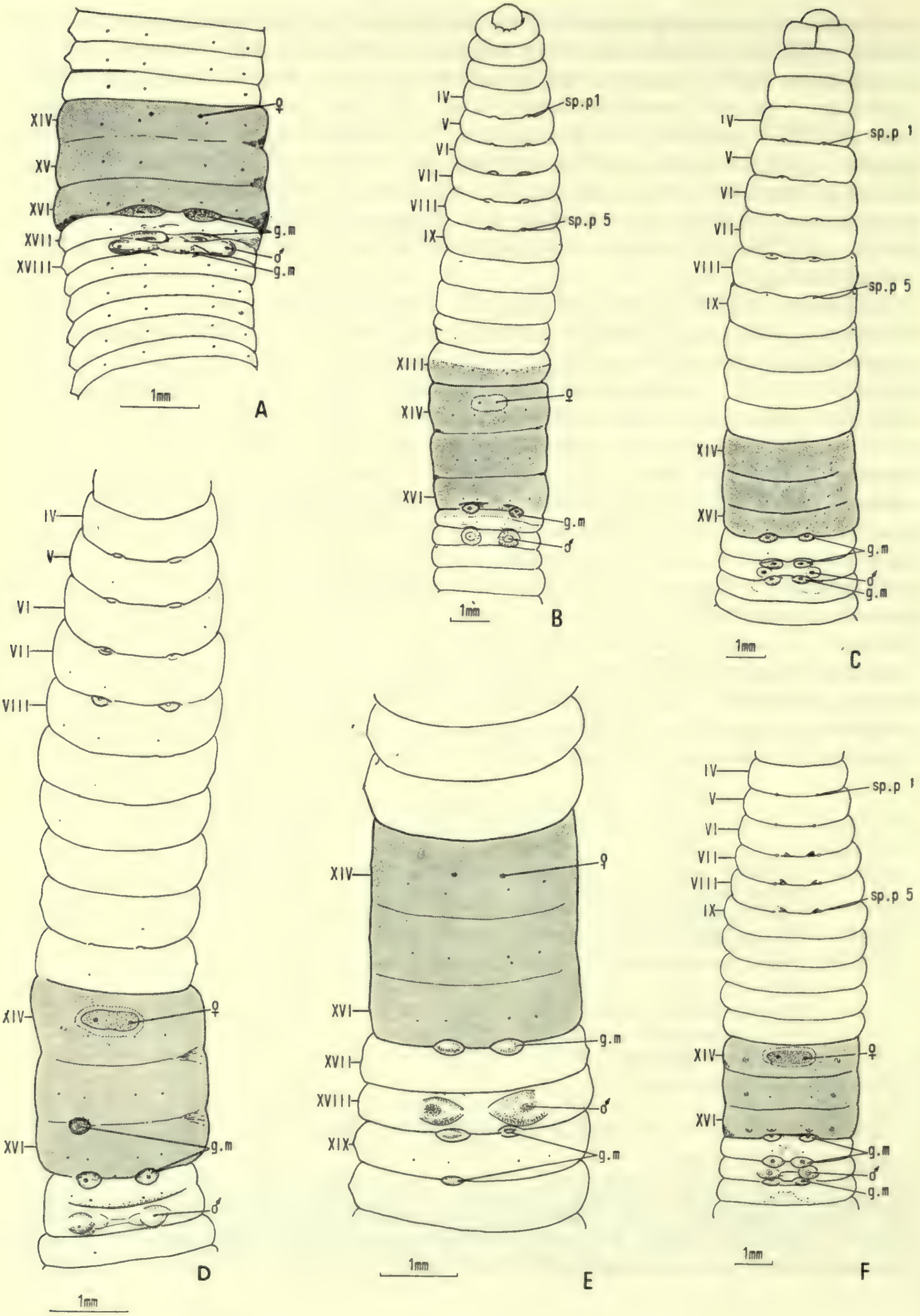
| | Specimen | | Total number of specimens |
|---|---|---|---|
| Paired presetal in *a* of VII | – | P1, 5 | 2 |
| Paired presetal in *a* of VIII | – | P5 | 1 |
| Paired presetal in *a* of IX | – | P3, 5 | 2 |
| Paired presetal in *b* of IX | – | P1 | 1 |
| Paired presetal in *b* of X | – | P1 | 1 |
| Paired presetal in *aa* of XVII | H | P2, 3, 5 | 4 |
| Paired presetal in *aa* of XVIII | H | P1–5 | 6 |
| Paired in *b* in 17/18 | H | P1–5 | 6 |

H = Holotype ; P = Paratypes.

Spermathecal pores and male porophores invariable in 6 specimens.

MATERIAL EXAMINED.

Hellyer Gorge, 145°35′E. 41°20′S. Map, 7/3, Dr J. L. Hickman, 28 May 1954 – holotype TM : K284 ; paratypes 1 and 2 BM(NH) : 1972.8.10–11 ; paratypes 3 and 4 AM : W5192–5193 ; paratype 5 BJ : T15. Mt Arthur, in rainforest, 147°20′E. 41°15′S. Map, 9/1, Mr A. J. Dartnall, 13 Mar 1971 – 2 specimens TM : K285–286.


XIV
XV
XVI
XVII
XVIII
♀
g.m
♂
g.m
1mm
A
IV
V
VI
VII
VIII
IX
sp.p1
sp.p 5
XIII
XIV
XVI
♀
g.m
♂
1mm
B
IV
V
VI
VII
VIII
IX
XIV
XVI
sp.p 1
sp.p 5
g.m
♂
g.m
1mm
C
IV
V
VI
VII
VIII
XIV
XVI
♀
g.m
♂
1mm
D
XIV
XVI
XVII
XVIII
XIX
♀
g.m
♂
g.m
1mm
E
IV
V
VI
VII
VIII
IX
XIV
XVI
sp.p 1
sp.p 5
♀
g.m
♂
g.m
1mm
F

REMARKS. This species is close morphologically to *P.* (*V.*) *montisarthuri* but is readily distinguished from it by the presence of postclitellar genital markings in *aa*.

### *Perionychella (Vesiculodrilus) hobartensis* (Spencer, 1895)

Fig. 1, 11A–F, 15A, B, 16P–R ; Plates 97, 98. Table 2

*Cryptodrilus hobartensis* Spencer, 1895 : 37–38, Pl. I, fig. 10, 11, 12.
*Plutellus hobartensis* ; Michaelsen, 1900 : 175–176 ; Jamieson, 1971c : 87.
*Cryptodrilus insularis* Spencer, 1895 : 41–42. Pl. 2 ; fig. 19–21 (new synonym).
*Plutellus insularis* ; Michaelsen, 1900 : 176 ; Jamieson, 1971c : 87.
*Vesiculodrilus hobartensis* ; Jamieson, 1973a : 225.
*Vesiculodrilus insularis* ; Jamieson, 1973a : 225.

l = 28 mm + (posterior regenerate), w = 2·7 mm, s = 91 +.

Form moderately stout ; approximately circular in cross section but flattened between adjacent setae. Prostomium epilobous ⅔, open but apparently with a transverse groove at about half peristomium ; a middorsal groove commencing on the prostomium and continuous throughout the body. First dorsal pore 4/5. Setae readily visible, in 8 regular longitudinal rows throughout, commencing on II ; *ab* absent, *cd* present, on XVIII.

Nephropores in *c* lines at the anterior borders of their segments (clitellum and posteriorly). Clitellum annular, strongly protuberant on XIV–XVI but XVII with clitellar modification, especially dorsally over the anterior third ; dorsal pores present but imperforate ; setae and intersegmental furrows retained but less distinct ; nephropores visible. Small indistinct (imperforate) male porophores in *ab* nearer *b*, of XVIII ; paired eye-like accessory genital markings in *a* lines in 16/17, 17/18 and 18/19, the anterior pair large and more conspicuous than the second pair, the posterior pair rudimentary. Female pores minute, shortly anteromedian of *a* in XIV, each with a distinctly visible white 'halo'. Spermathecal pores not visible.

Last hearts in XII (latero-oesophageal) ; connections of the 4 pairs of hearts with the dorsal vessel presumably present but not verified with certainty as hearts were brittle and were separate from the dorsal vessel on examination. Supra-oesophageal well developed in VIII–XII, and with a slender posterior continuation into XIII and apparently intramurally to ½XV.

Gizzard in V, almost cylindrical and only slightly wider than the oesophagus but recognizable by its muscular sheen ; easily compressible ; preceded in IV by a less muscular proventriculus of the same width, from which it is not separated by any appreciable constriction. Oesophagus narrow (though not much narrower than the gizzard) and not evidently vascularized in VI and VII ; still narrow but with intramural circumferential vascular striae, which form the supra-oesophageal vessel in VIII–XI ; forming a segmental unpaired annular dilatation in each of segments XII,

FIG. 11. Genital fields. *Perionychella* (*Vesiculodrilus*) *hobartensis* : A, lectotype ; B, 13/6, TM : K293 ; C, 14/2, TM : K299 ; D, 14/1, TM : K294 ; E, 19/2, AM : W5194 ; F, 14/6, TM : K306.

XIII and XIV, the dilatations increasing in size posteriad; the oesophagus also widened, but less so, to ½XV but narrow and chloragenous looking in the posterior half of this segment; the internal walls of the dilatations with rounded longitudinal ridges too low to be considered lamellae. Intestinal origin XVII; typhlosole absent.

Genital markings

| Specimen | | Paired genital markings | | | | | |
|---|---|---|---|---|---|---|---|
| | | 15/16 | 16/17 | 17/18 | 18/19 | 19/20 | 20/21 |
| Spencer, 1895 | | | + | + | + | + | |
| Lectotype | | | + | + | + | ? + | |
| 7/2 | TM : K288 | | + | + | + | + | |
| 8/2 | TM : K289 | + | R | | | | |
| 8/2 | TM : K290 | + | + | | | | |
| 10/1 | TM : K291 | | | + | | + | + |
| 10/1 | TM : K292 | | | + | | + | + |
| 13/6 | TM : K293 | | + | | | | |
| 14/1 | TM : K294 | R | + | | | | |
| 14/1 | TM : K295 | | + | | | | |
| 14/1 | TM : K296 | | + | | | | |
| 14/1 | TM : K297 | | + | | | | |
| 14/2 | TM : K299 | | + | + | + | | |
| 14/3 | TM : K300 | | + | + | + | ? | |
| 14/4 | TM : K302 | | + | L | + | + | |
| 14/5 Lenah V | TM : K304 | | + | + | + | + | |
| 14/5 Sandy Bay | TM : K305 | | + | + | + | + | R |
| 14/6 Risdon | TM : K306 | | + | + | | | |
| 14/6 E. Risdon | BM(NH) : 1972.8.15 | | + | + | + | | |
| 14/6 | BM(NH) : 1972.8.16 | | + | + | + | + | |
| 14/6 | BM(NH) : 1972.8.17 | | + | + | + | | |
| 19/2 | AM : W5194 | | + | | + | R | |
| 19/2 | AM : W5195 | | + | | + | | |
| 19/3 | TM : K308 | | + | + | | | |

L = left only; R = right only.

Nephridia simple vesiculate holonephridia throughout; the first discharging at intersegment 2/3, each with a wide elongate bladder bent into a U or J shape, all bladders discharging in front of setae *c*; 'necks' to septa seen but no funnels demonstrated with certainty. Holandric (funnels iridescent in X and XI); seminal vesicles not recognizable. Prostates represented only by thick muscular ducts each with the form of a short, straight, entally narrowing cone. Penial setae not detectable in the lectotype and not reported by Spencer (1895); demonstrated in one or (loc. 19/2) two specimens from each of localities 7/2, 8/2, 10/1, 14/1, 14/5, 14/6 and 19/2; filiform and sinuous, tip frequently worn or damaged but intact in 14/5 and 14/6 in which it is widely bifid, while simple and hooked in 7/2; ornamentation a few faint longitudinal ridges (14/5, 14/6) or groups of several scarcely protuberant, approximately palmately arranged, apically directed teeth at intervals near the tip (7/2) or a few very faint triangular marks and longitudinal ridges (14/6); length = 0·97, 1·56 mm (19/2), 1·71 mm (14/6). Ovaries (laminate with several strings of large oocytes) and stout funnels in XIII; ovisacs absent. Spermathecae 5 pairs, the last in IX; with ovoid ampulla sessile on the body wall and a lateral clavate diverticulum as long as or longer than the ampulla. In one spermatheca the diverticulum is very short and there is a further diverticulum on the median aspect of the spermatheca further entally. Length of the right spermatheca of IX = 0·75 mm; ratio total length : length diverticulum = 0·8.

*Other variations.* Spermathecal pores are 4 pairs in the material listed above from localities 7/2 and 14/1, but 5 pairs in all other specimens examined. The gizzard is very large in specimens from locality 10/1, small to vestigial in all others. Intestinal origin is XVII (Spencer 1895; lectotype; localities 8/2, 10/1, 13/6, 14/2, 14/3, 14/4, 14/5, 14/6); ½XVII (locality 14/1); XVI (locality 14/6, 19/2) or ½XVI (locality 7/2). Penial setae are present in all specimens examined with the exception of the lectotype. The latter specimen lacks seminal vesicles, has prostate ducts but no glands and has abnormal spermathecae. These features suggest that it is a parthenogenetic, uniparental morph and that absence of penial setae, in a species normally possessing these, is further evidence of parthenogenesis.

Ovisacs were demonstrated for specimens from all localities excepting 13/6 and 14/5 and the lectotype.

TYPE-LOCALITIES. Parattah and Mt Wellington.

MATERIAL EXAMINED.

Parattah, 147°25′E. 42°20′S. Map, 14/1, Baldwin Spencer collection, Jan 1893 – the previously undissected, clitellate lectotype, in poor condition, NMV : G50. The two paralectotypes, G51, were examined but were not used for the above account as one is broken in two at the clitellum and the other is imperfectly clitellate.

The following new material has been identified on external and internal anatomy: Fern Glade, Emu River, 145°55′E. 41°05′S. Map, 7/2, Dr J. L. Hickman, 24 Aug 1954 – TM : K287–288. Great Lake, near stones around base of gum tree, slopes of lake, 146°45′E. 41°55′S. Map, 8/2, Dr J. L. Hickman, 26 May 1954 – TM : K289–290. Goulds County, near Lottah, fireplace at creek, 148°05′E. 41°15′S. Map 10/1, Dr J. L. Hickman, 16 Apr 1954 – TM : K291–292. Marlborough Highway, near Bronte, 146°30′E. 42°10′S. Map, 13/6, Dr J. L. Hickman, 26 May 1954 – TM : K293. Parattah (type-locality) 147°25′E. 42°20′S. Map, 14/1, under moss, in earth at base of cliff, also in earth along sides of logs. Map, 14/1, Professor V. V. and Dr J. L. Hickman, 18 Aug 1954 – TM : K294–298. Tunnack, under logs and stones, damp conditions, 147°30′E. 42°25′S. Map, 14/2, Dr J. L. Hickman, 18 Aug 1954 – TM : K299. Collinsvale near Hobart, Myrtle Forest, 147°05′E. 42°50′S. Map, 14/3, Dr J. L. Hickman, 8–9 Nov 1955 – TM : K300–301. Mt Wellington (type-locality) 147°15′E. 42°55′S. Map, 14/4: under stones, creek, Bett's Vale, Dr J. L. Hickman, 4 Mar 1954 – TM : K302; Shoobridge Bend Track, approx. 580 m altitude, in loam and clay in Eucalypt-fern woodland, B. G. M. Jamieson and E. Bradbury, 19 Aug 1971 – TM : K303. Lenah Valley, near Newton Falls, 147°20′E. 42°50′S. Map, 14/5, Dr J. L. Hickman, 24 Jun 1957 – TM : K304. Mt Nelson, Sandy Bay, 147°20′E. 42°55′S. Dr J. L. Hickman, 11 Sep 1953 – TM : K305. Risdon, 147°20′E. 42°50′S. Map, 14/6, Professor V. V. Hickman, 26 Jun 1947 – TM : K306–307; East Risdon, from under stones on hill and in valley, Dr J. L. Hickman, 14 Aug 1954 – BM(NH) : 1972.8.15–17. Eaglehawk Neck, under bark, 147°55′E. 43°00′S. Map, 19/2, Dr J. L. Hickman 1954 – AM : W5194–5198; BJ : T16–18. Tinderbox, under fallen eucalyptus leaves, 147°20′E. 43°05′S. Map, 19/3, Dr J. L. Hickman, 4 Aug 1957 – TM : K308.

REMARKS. The above account of the lectotype confirms and considerably augments Spencer's description. As shown in the table of field-variation, the accessory

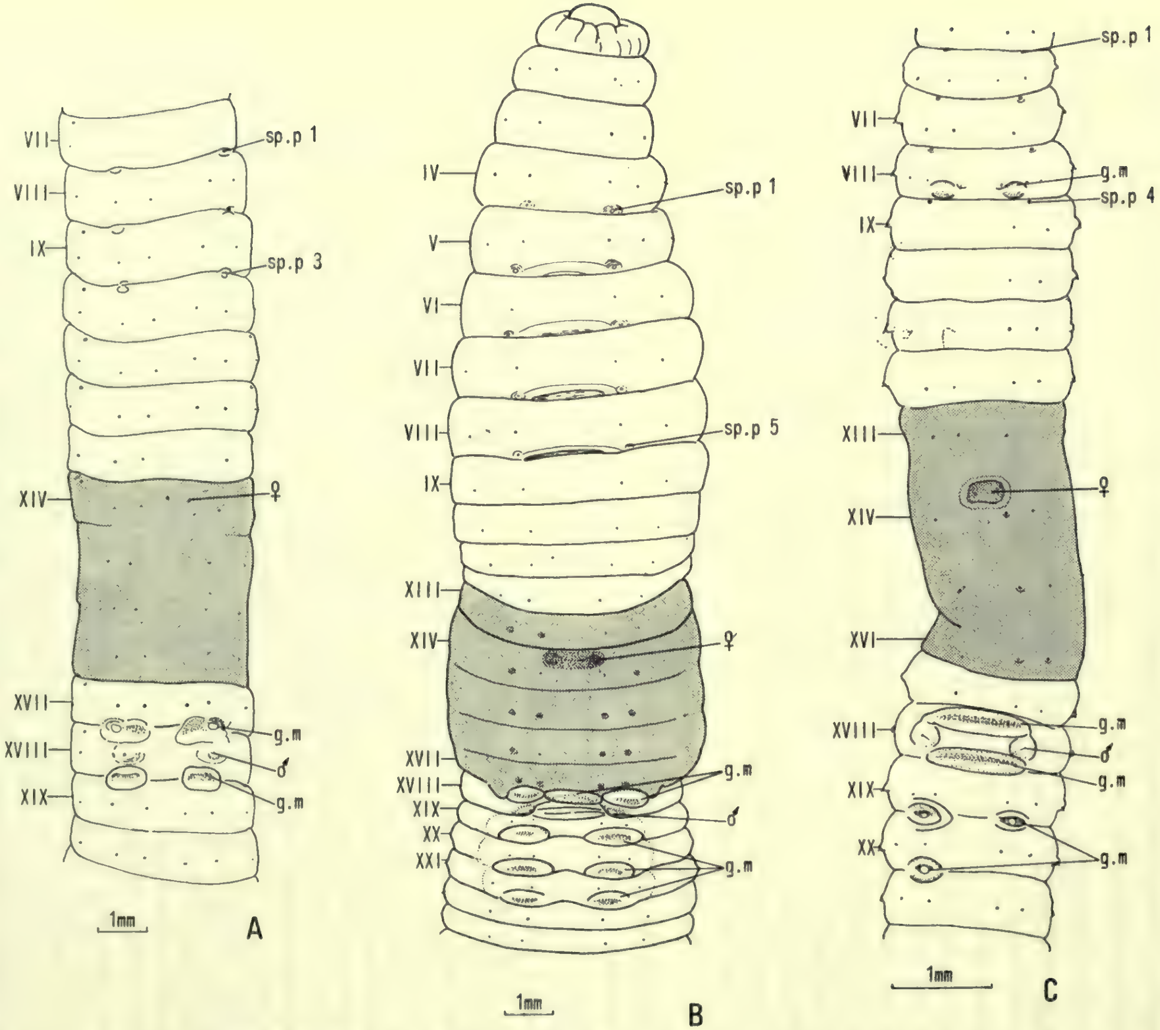

VII
sp.p 1
VIII
IX
sp.p 3
XIV
♀
XVII
g.m
XVIII
♂
XIX
g.m
1mm
A
IV
sp.p 1
V
VI
VII
VIII
sp.p 5
IX
XIII
XIV
♀
XVII
XVIII
g.m
XIX
♂
XX
XXI
g.m
1mm
B
sp.p 1
VII
VIII
g.m
sp.p 4
IX
XIII
♀
XIV
XVI
XVIII
g.m
♂
g.m
XIX
XX
g.m
1mm
C

FIG. 12. Genital fields. A, *Perionychella* (*Vesiculodrilus*) *montisarthuri*, holotype. B, *P.* (*V*). *mortoni*, 14/4, BM(NH) : 1972.8.19. C, *P.* (*V.*) *pedderensis*, holotype.

genital markings were more numerous in the material described by Spencer but the evidence offered by Jensz and Smith (1969) for regarding the lectotype which they selected as part of the type-series is satisfactory. Location of paired genital markings in intersegmental furrow 16/17 is almost constant for the species, the sole exceptions in the material examined being those from Goulds County (10/1). The latter specimens are also exceptional in having genital markings in 20/21 (seen, however, in the right side in a Sandy Bay specimen (14/5)) and have a very large gizzard. The possibility that these, and perhaps specimens from other localities, are subspecifically or specifically distinct from the type-population deserves further investigation but on present evidence recognition of distinct taxa is not justified.

### ***Perionychella (Vesiculodrilus) lacustris*** (Stephenson, 1924)

Fig. 1, 7B, 16I

*Perionyx lacustris* Stephenson, 1924 : 546–547.
*Diporochaeta lacustris* : Jamieson, 1971b : 83.

l = 45–60 mm, w = 2·4–3·0 mm, s = 95–107.

Prostomium epilobous $\frac{4}{5}$, wedge-shaped (type) or tanylobous (Bronte). First dorsal pore 4/5. Setae on XII 18 (type), 22 (Stephenson), 14 and 16 (Bronte); caudally (Bronte) 16 and 23; 20 on V and XIX, 22 on IX (Stephenson). The dorsal setal gap regular anteriorly and in the midbody equalling 2–3*yz*, but irregular and indistinct caudally; ventral gap regular throughout, equalling or > 2*ab* anteriorly. Clitellum annular $\frac{1}{2}$XIII–$\frac{1}{2}$XVII. Male pores in *b* on prominent ovoid papillae occupying *ac* on XVIII. Paired eye-like markings in *bc* in 16/17, 17/18 and 18/19, those of 17/18 slightly median of the others; a median sucker-like pad postsetal ventrally in each of VII and VIII; an indistinct glandular tumescence present on each side in *ac* on XVII and XIX. Female pores paired in XIV anteromedian of *a*. Spermathecal pores 3 pairs, in 6/7 to 8/9, on small papillae in *cd*, closer to *c*.

Last hearts in XII (latero-oesophageal). Supra-oesophageal in VIII–XII, well developed. Gizzard small, almost vestigeal, in V, hidden in septal glands. Calciferous glands absent but in the type the oesophagus is swollen and vascularized, and has low internal rugae, in XIV and XV. Intestinal origin $\frac{1}{2}$XVII; typhlosole absent. Nephridia simple, stomate, vesiculate, exonephric holonephridia commencing (but rudimentary ?) in II (preseptal funnel demonstrated in XIV); bladders large, subspherical, tapering ectally or, in the type, represented at most by slight intraparietal dilatations of the terminal duct. Holandric (funnels iridescent); gymnorchous; seminal vesicles racemose, in IX and XII. Metagynous; ovisacs large in XIV. Prostates tubuloracemose, in XVII to XX (type) or to XXI, XXII (Bronte); only partially resolvable into a simple linear arrangement; depressed, deeply incised and lobulated; vas deferens (see in Bronte specimens only) joining gland near its muscular duct. Penial setae delicate, filiform, sharply pointed; apical extremity rounded; ornamentation absent; length ? Penial setae present in the type but not examined. Spermathecae 3 pairs; diverticulum (inseminated) single, clavate, uniloculate.

TYPE-LOCALITY. Great Lake, under stones in water at margin of the lake, 146°45′E. 41°55′S. Map, 8/2.

MATERIAL EXAMINED.

Syntypes, BM(NH) : 1924.10.21.1–5, of which one, referred to as 'type' in the above account, was closely examined.

Lyell Highway, 5 miles from Bronte towards Hobart, 146°35′E. 42°15′S. Map, 13/7, Dr J. L. Hickman, 24 May 1954 – two specimens TM : K265 and BM(NH) : 1972.8.2.

REMARKS. The new description of a type-specimen in the above account considerably augments Stephenson's description. In this type-specimen, which had not been previously dissected, and in the single one of the type-specimens which had previously been dissected, the following observations of Stephenson are not confirmed and are considered incorrect : clitellum in XIV–XVI ; gizzard in VI ; intestinal origin (about) XVIII ; penial setae absent. Genital markings are similar in the two specimens and include midventral markings in VII and VIII.

*P.* (*V.*) *montisarthuri* is morphologically close to this species but shows sufficient differences to be considered a distinct species. These differences include the setal counts, the bilobed nephridial vesicles, the sessile spermathecae and the precise configuration of the genital field.

## ***Perionychella (Vesiculodrilus) montisarthuri*** sp. n.

Fig. 1, 12A, 15H, 16S. Table 2

l = 79 mm, w = 3·6 mm, s = 86.

Prostomium epilobous ½, open. First dorsal pore 3/4. Setae on XII 8 (10 on XI) ; caudally, 14 or 16 per segment ; the dorsal gap regular anteriorly and, in the mid-body, equalling *2yz*, irregular caudally ; ventral gap regular throughout, equalling *2ab* anteriorly. Nephropores in a single straight series on each side in setal line 3 anteriorly and in the mid-body ; caudally in s.l. 4–5. Clitellum, annular ½XIII–XVI. Male pores in *b* on small, flat, ovoid markings on XVIII ; two ovoid genital markings occupy the space from *a* to a little lateral of *b* at 17/18 and 18/19. Female pores paired on XIV, anterior and slightly median to *a*. Spermathecal pores 3 pairs in *b* in 6/7–8/9, on small papillae each of which is succeeded by a small ovoid marking on the posterior segment.

Last hearts in XII (latero-oesophageal). Supra-oesophageal in VIII–XII, well developed. Gizzard in V, moderately large but only weakly muscular. Calciferous glands absent. Oesophagus with circumferential vascular striae in VII–XIV, widest in XIV and XV in which internally there are numerous radial lamellae which almost occlude the lumen ; narrow in XVI in which there are a few, low radial folds. Intestinal origin ½XVII ; typhlosole absent. Nephridia simple stomate, vesiculate, exonephric holonephridia commencing in II (funnels demonstrated in the forebody) ; bladders at first elongate avoid but by VI with a suggestion of a lateral basal lobe ; thereafter the lateral lobe increases in size relative to the median portion (the latter receiving the nephridial duct) until, by about XIX, the bladder is broader than long and consists of two approximately equal lobes, the lateral lobe constituting a broadly sessile diverticulum ; caudally the bladders are less distinctly bilobed. Holandric (funnels iridescent in X and XI), gymnorchnous ; seminal vesicles racemose, in IX and XII. Metagynous ; ovisacs small in XIV. Prostates depressed very tortuous tubes, in XVII-XXI ; double vas deferens joining the gland shortly ental of the slender, sinuous muscular duct. Penial setae (holotype) slender, strongly curved, almost filiform with delicate thinner, elongate tip ; ensheathed in setal follicle and not suitable for electron microscopy ; length (?), incomplete. Spermathecae 3 pairs, diverticulum (inseminated) single, clavate, uniloculate, exceptional in joining the ectal end of the broad subspherical ampulla ; ampulla almost sessile on the parietes.

MATERIAL EXAMINED.

Mt Arthur, from rainforest, 147°20'E. 41°15'S. Map, 9/1, Mr A. J. Dartnall and Mr R. C. Kershaw, 15 Oct 1971 – holotype TM : K309.

REMARKS. This species is morphologically close to *P.* (*V.*) *hellyeri* (q.v.)

## ***Perionychella (Vesiculodrilus) mortoni*** (Spencer, 1895)

Fig. 1, 12B, 15E–G, 16T ; Plates 99–102. Table 2

*Cryptodrilus mortoni* Spencer, 1895 : 36–37, Pl. 1, fig. 7–9.
*Plutellus mortoni* ; Michaelsen, 1900 : 176.
*Woodwardiella mortoni* ; Jamieson, 1970 : 104, 105 ; 1971c : 92.

Dimensions (see Variation). Anatomy (specimen 1, locality 14/4, 19 Aug 1971) : Prostomium canaliculate, tanylobous. First dorsal pore 4/5. Setae in 8 regular longitudinal rows throughout. Nephropores conspicuous, commencing anteriorly in II in *c* lines but shortly below *c* lines behind the midclitellum. Clitellum annular, XIII–XVII, strongly developed and pigmented in XIV–XVII, unpigmented and weakly developed in XIII ; possibly some slight clitellar modification in XVIII. Male pores on small papillae in *ab* of XVIII. Accessory genital markings : paired elliptical pads with depressed centres in *ab* in 17/18, 19/20, 20/21 and 21/22, those in 17/18 with centres slightly lateral of those of the other markings and truly intersegmental ; the markings in 19/20–21/22, though intersegmental actually postsetal in XIX–XXI, respectively ; a median elliptical pad present in 17/18 bridging the paired markings of the intersegment. Median markings each with the form of a depressed transverse intersegmental band with anterior rim in *aa* in 5/6–8/9. Female pores anteromedian of setae *a* of XIV, midway between the setal arc and anterior border of the segment in a common oval field. Spermathecal pores 5 pairs on minute circular papillae immediately in front of intersegmental furrows 4/5–8/9, in *a* lines.

Last hearts in XII (latero-oesophageal). Supra-oesophageal well developed, in VIII–½XIII. Gizzard very large and firm, in V but projecting posteriorly to the level of XI. Calciferous glands absent. Oesophagus strongly vascularized and increasingly dilated in XIII–XVI with well-developed internal vascular rugae, especially in XV and XVI. Intestinal origin XVIII ; typhlosole absent. Nephridia stomate, vesiculate exonephric holonephridia commencing in II (preseptal funnel demonstrated for those of II); tortuously coiled but simple, none tufted; bladders at first elongate, wide tubes, each of slightly irregular diameter; by XII bent midway at a right angle; thereafter with a lateral diverticulum extending from the bend, the portion ectal to the diverticulum being eliminated after a few segments. Holandric (funnels iridescent in X and XI); gymnorchous; seminal vesicles racemose in IX and XII. Metagynous; ovisacs present. Prostates much coiled depressed tubes, in XVIII–XXI; vas deferens joining the duct shortly ectal of the gland. Penial setae short and moderately stout, the tip irregular, widened, roughly spatulate and bent a little or through a right angle, this apical modification visible under the light microscope; shaft ornamented ectally with a few groups of anteriorly directed scarcely protuberant teeth regularly spaced along it; the surface of the seta undercut beneath them; length 0·5 mm (3 setae, Mt Wellington and East Risdon specimens, as illustrated). Spermathecae 5 pairs; diverticulum (inseminated) single, clavate, uniloculate.

*Variation.* A minimum of two specimens from each of localities 7/2, 9/2, 14/3, 14/4, 14/5, 14/6 and the single specimen from 19/2 were examined for variation in external characters. Variation in internal anatomy is described for at least one specimen from each locality.

*Genital markings.* Postsetal genital markings were present in *aa* in each of segments IV–VIII in all specimens but in those from Fern Glade (locality 7/2) these were exceptional in being paired. Paired markings were present in 17/18 and postsetally in each of segments XIX, XX and XXI, with the exception that those in XXI were absent in one of the two specimens from each of localities 9/2, 14/3 and 14/5 and from most East Risdon specimens (14/6). The median genital marking in 17/18, though characteristic of the species, is absent from most but not all of the East Risdon specimens.

Spencer did not observe genital markings in IV–IX (these are often faint in the new material) but he depicted median and paired markings in 17/18, as here described, and paired markings in intersegments 18/19 and 19/20. The latter two pairs were presumably postsetal rather than intersegmental and it appears probable from the present study that they lay in segments XIX and XX.

*Other variation.* $l = 56$–$212$ mm, $w = 3{\cdot}5$–$6{\cdot}5$ mm, $s = 113$–$274$. Prostomium epilobous $\frac{1}{2}$–$\frac{2}{3}$, epitanylobous or tanylobous; often canaliculate. First dorsal pore usually in 4/5, rarely in 3/4 or 5/6. Body strongly canaliculate to not canaliculate.

Variation from the description in internal characters occurs in the intestinal origin which is XVII in 9/2 and 19/2; in the presence of a low dorsal intestinal ridge, though no true typhlosole is present, in 9/2 and 14/6; and in the absence of diverticula of the nephridial bladders in 9/2. Absence of nephridial diverticula is especially noteworthy and is a variation hitherto unknown intraspecifically in otherwise diverticulate species. At present there is insufficient justification for taxonomic recognition of the variant.

### MATERIAL EXAMINED.

Approximately 100 sexual specimens were examined from the following localities: Fern Glade, Emu River, Burnie, 145°55′E. 41°05′S. Map, 7/2, Dr J. L. Hickman, 24 Aug 1954. Mt Arthur (east), wet sclerophyll forest, 147°20′E. 41°15′S. Map, 9/1, Mr A. J. Dartnall and

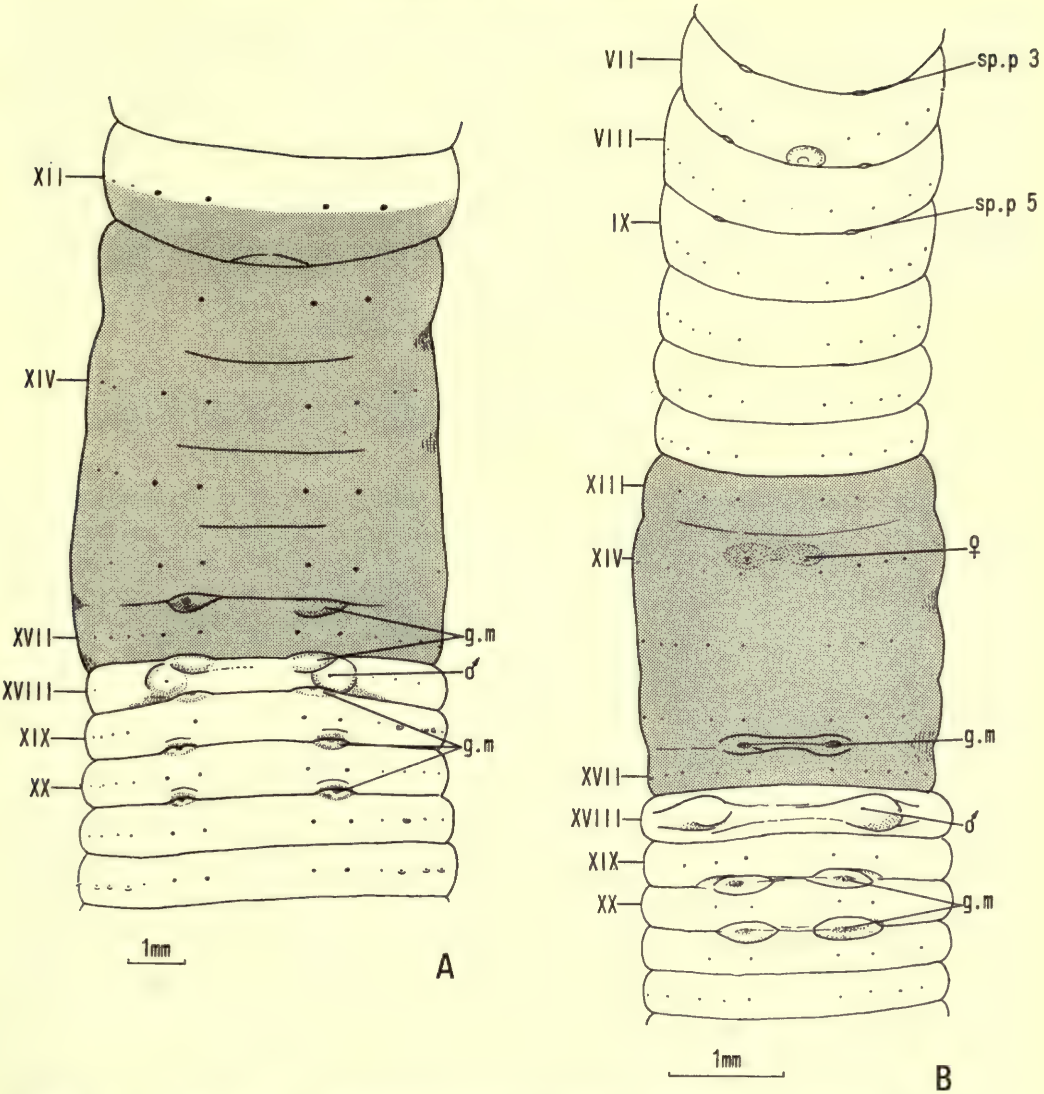


FIG. 13. Genital fields. *Perionychella* (*Vesiculodrilus*) *obliquae* : A, holotype ; B, 17/1, AM : W5202.

Mr R. C. Kershaw, 15 Nov 1971. St Columba Falls, 147°55′E. 41°20′S. Map, 9/2, Dr J. L. Hickman, 17 Apr 1954. Collinsvale, near Hobart, in Myrtle Forest, 147°10′E. 42°50′S. Map, 14/3, Dr J. L. Hickman, 8–9 Nov 1955. Mt Wellington, 147°15′E. 42°55′S. Map, 14/4, Dr J. L. Hickman, 13 Jan 1954 ; Dr J. L. Hickman, 27 Oct 1955 ; Mr W. Radford, Apr 1952 ; Professor V. V. Hickman, 28 Jun 1947 ; 13 Sep 1951 – BJ : T19–20 ; Betts Vale, Dr J. L. Hickman, 4 Mar 1954 – AM : W5199–5201 ; Shoobridge Bend track, approx. 580 m, Dr B. G. M. Jamieson and Mr E. A. Bradbury, 19 Aug 1971 – BM(NH) : 1972.8.18–25. Hobart, Waterworks Road, under stones, 147°20′E. 42°50′S. Map, 14/5, Dr J. L. Hickman, 17 Aug 1954. Lenah Valley, track along Newtown Creek, Dr J. L. Hickman, 15 Sep 1953 ; Lenah Valley, under stones near Newtown Falls, Dr J. L. Hickman, 24 Jun 1957 – BM(NH) : 1972.8.26–30;

Sandy Bay, Dr J. L. Hickman, Sep 1954; Domain, 14 Aug 1954. East Risdon, under stones on hill and in valley, 147°20′E. 42°50′S. Map, 14/6, Dr J. L. Hickman, 14 Aug 1954 – BJ: T21–22; Risdon, Professor V. V. Hickman, 26 Jun 1947. Eagle Hawk Neck, 147°55′E. 43°00′S. Map, 19/2, Dr J. L. Hickman, 13 May 1954. Tasmania: T.M. 15527/K97, Dr J. L. Hickman. All specimens lodged in the Tasmanian Museum (K97, K402–419) except where indicated above.

REMARKS. This species and *P.* (*V.*) *hobartensis* are the most widespread and commonly found megascolecid earthworms in Tasmania and are morphologically close. A notable difference is location of the paired genital markings at the posterior borders of their segments in *mortoni* whereas in *hobartensis* they are intersegmental.

### ***Perionychella (Vesiculodrilus) obliquae*** sp. n.

Fig. 1, 13A, B, 16U, V

l = 115 mm (holotype; paratype 1 is a posterior amputee), w = 6·6, 6·0 mm, s = 118.

Prostomium epilobous ½, open. First dorsal pore 3/4. Setae on XII 27, 25; caudally 40, 38; ventral break distinct throughout, equal to 2*ab* in forebody and 3*ab* posteriorly; dorsal gap not distinct caudally being equal to dorsal couple (*yz*); distinct anteriorly, equalling 2*yz*. Nephropores difficult to observe, anteriorly in setal lines 6 and posteriorly in s.l. 8 (holotype) or 8–9 (paratype 1). Clitellum annular, ½XII–XVII. Male pores on small papillae in *b* lines. Five pairs of eye-like markings on the anterior margins of segments XX and XXI in *b* lines and on segments XVII, XVIII and XIX in *ab*. Female pores paired anterior and a little median to *a* on XIV. Spermathecal pores 5 pairs, in 4/5–8/9 in *ab* on small papillae.

Last hearts in XII (latero-oesophageal). Supra-oesophageal in VII–XIII, very well developed. Gizzard small, almost vestigial, in V. Extramural calciferous glands absent; intestinal origin ½XVII; typhlosole absent. Nephridia simple exonephric, vesiculate holonephridia commencing in II; preseptal funnels present at least from III posteriorly; bladders long, tubular or somewhat dilated, bent into a U or V shape. Holandric (funnels iridescent); gymnorchous; seminal vesicles racemose, in IX and XII. Metagynous; large ovisacs in XIV. Prostates depressed tubular, somewhat lobulated, with several bends compacted into a circular outline and spuriously appearing racemose, in XVII–XIX. A small follicle but no seta present in *a* of XVIII in the holotype; penial seta from AM: W5202 very slender, straight, unornamented (under light microscope), length = 0·58 mm; a vestigial seta from paratype under the electron microscope displays no ornamentation; tip pointed, aquiline, length = 0·34 mm. Spermathecae 5 pairs; diverticulum (inseminated) single, clavate, uniloculate.

MATERIAL EXAMINED.

*Obliqua*-forest, 2 miles inland, south of Interview River, 144°55′E. 41°35′S. Map, 6/1, Mr W. Jackson, 31 Dec 1953 – holotype TM: K310; paratype 1 BM(NH): 1972.8.31. Port Davey, Kelly's Beach, 145°55′E. 43°20′S. Map, 17/1, Tasmanian Biological Survey: J17, Jan 1940 – AM: W5202.

REMARKS. Differences from the Interview River type-specimens shown by the Port Davey specimen are as follows: clitellar width 2·7 mm; first dorsal pore 4/5;

setae 22 in segment XII; accessory genital markings absent at 17/18 and 18/19; a midventral circular genital marking present posteriorly in VII (possibly an artefact); gizzard moderate in size; intestinal origin XVII, not ½XVII; nephridial bladders subspherical though ectally tapering. These differences do not appear sufficient for recognition of a distinct species for the Port Davey material, especially as only a single specimen is available. Larger series from both localities are needed.

The genital field of this species is reminiscent, though substantially different from, that of *P.* (*V.*) *hobartensis* which *obliquae* closely resembles. It differs conspicuously from *hobartensis* and from *P.* (*V.*) *tunnackensis*, to which it is also morphologically close, in the perichaetine arrangement of its setae.

### ***Perionychella (Vesiculodrilus) pedderensis*** sp. n.

Fig. 1, 12C, 16W

l = 50 mm, w = 1·6 mm, s = 123.

Prostomium canaliculate, indistinctly epilobous ½, open. Dorsal pores absent. Forebody dorsoventrally depressed; hindbody with wide dorsal gutter; anus terminal but deeply incising the pygidium dorsally and ventrally. Setae 10 per segment anteriorly, increasing to 12 per segment caudally, rows regular; dorsal and ventral gaps large, the dorsal larger. Nephropores ? Clitellum annular, XIII–XVI. Male pores in *ab* of XVIII on small papillae. Accessory genital markings: a midventral tumid pad traversing *bb* in each of intersegments 17/18 and 18/19, each pad with a deep groove corresponding with the intersegment; paired eye-like genital markings centred in *a* lines in 19/20 and 20/21 (that on the left in 20/21 barely perceptible) and posteriorly in VIII shortly lateral of *a* lines. Female pores at ⅓ *aa*, midway between the setal arc and the anterior border of XIV. Spermathecal pores 4 pairs, minute, in 5/6 shortly lateral of *a*, in 6/7 in *ab*, in 7/8 and 8/9 in *b*.

Last hearts XII. Suboesophageal VIII–XIII. Gizzard moderate, in VI. Oesophagus simple; intestinal origin XVII; typhylosole absent. Holonephridia commencing in II but appearing rudimentary to VII; each with a thick-walled subspherical bladder discharging presetally in *c* line; preseptal funnel well developed. Holandric (funnels iridescent); gymnorchous; seminal vesicles racemose, in IX and XII. Metagynous; large ovisacs in XIV. Prostates thickly tubular, 1 pair, in XVIII–XIX, or XX; vas deferens joining ectal limit of gland. Penial setae present (holotype) but structure not elucidated; no visible ornamentation; length (incomplete ?) = 0·41 mm. Spermathecae 4 pairs; diverticulum (inseminated) single, clavate, uniloculate.

MATERIAL EXAMINED.

Lake Pedder, sorted from interstitial fauna, 146°10′E. 42°55′S. Map, 13/2, Mr D. Tyler, 25 Feb 1971 – holotype TM: K311.

REMARKS. The absence of dorsal pores, which is unique in the genus in Tasmania, and the reduction of the anterior nephridia are elsewhere correlated with an aquatic existence in megadriles.

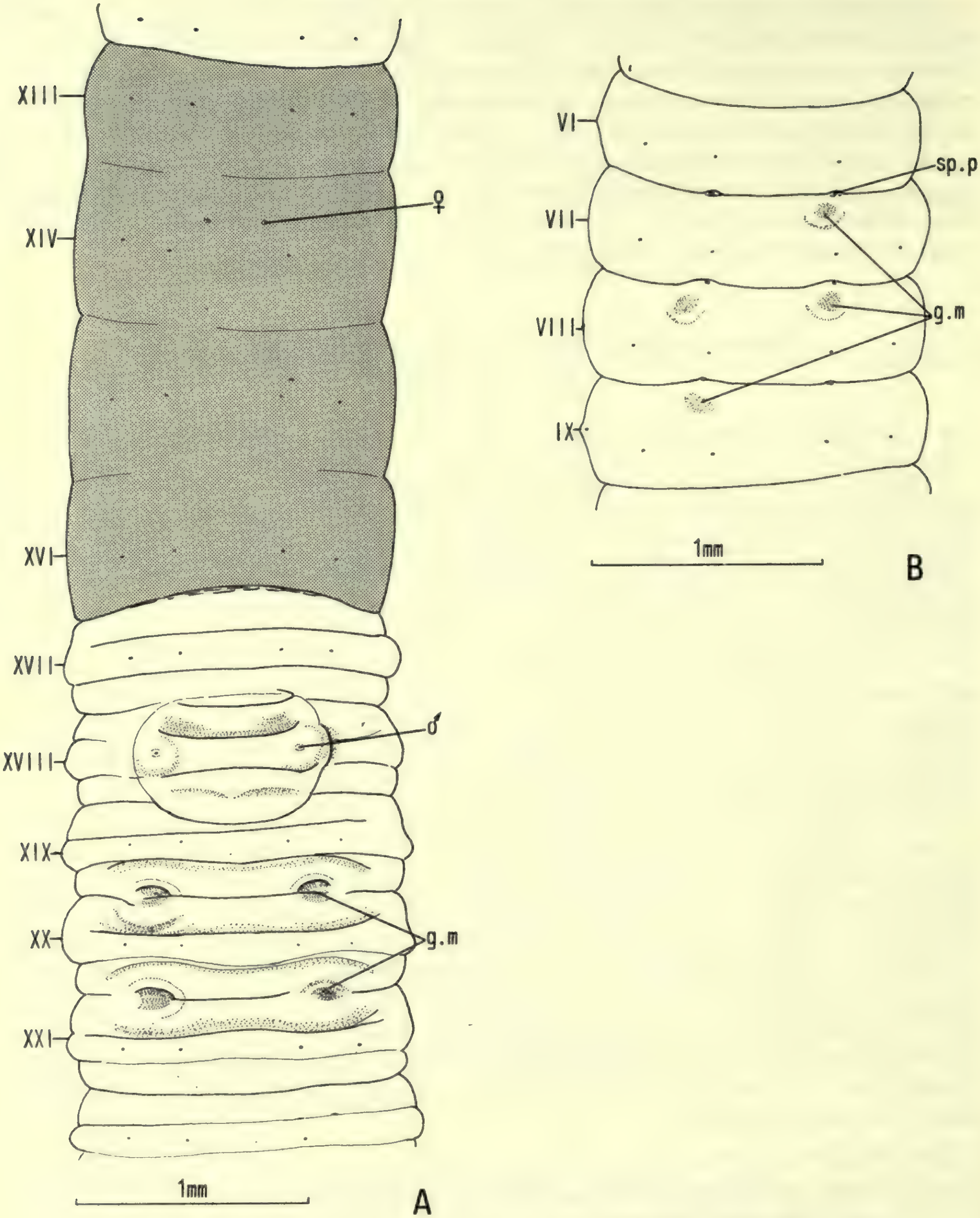

XIII
XIV
XVI
XVII
XVIII
XIX
XX
XXI
♀
♂
g.m
1mm
A
VI
VII
VIII
IX
sp.p
g.m
1mm
B

FIG. 14. Genital fields. *Perionychella* (*Vesiculodrilus*) *tunnackensis*, holotype: A, male field; B, spermathecal field.

### ***Perionychella (Vesiculodrilus) tunnackensis*** sp. n.

Fig. 1, 14A, B, 16X. Table 2

l = 33, 35 mm, w = 1·4, 1·3 mm, s = 82, 81.

Prostomium faintly canaliculate, epilobous ½. First dorsal pore 4/5. Setae 8 per segment in regular longitudinal rows throughout. Nephropores in *c*. Clitellum annular, 13–16. Male pores in *ab* on small papillae on 18, the two papillae joined by a low median ridge, intersegmental ridges at 17/18 and 18/19 flank the male papillae and correspond in extent to the ridge between the papillae. Paired eye-like transversely conjoined genital markings in *ab* at 19/20 (holotype, paratype) and 20/21 (holotype); post-setal eye-like markings occur with centres in *a* in VII (paired in paratype; left only in holotype); VIII (paired) and IX (paired in paratype 1; right only in holotype). Female pores a pair anteromedian of *a* on XIV. Spermathecal pores 3 pairs in *a* at 6/7, 7/8 and 8/9.

Last hearts in XII (latero-oesophageal). Supra-oesophageal not distinguishable from the well-developed oesophageal plexus. Gizzard in V, moderate to small, muscular but easily compressible. Calciferous glands absent. Oesophagus with circumferential vascular striae in (VII ?), VIII–XV; in X–XV with at first few and small, posteriorly increasingly numerous and larger longitudinal rugae which in XIV and XV approach the appearance of laminae. Intestinal origin XVII; typhlosole absent. Nephridia simple stomate, vesiculate holonephridia, commencing in II (funnels traced at least from IV); bladders subspherical, tapering to the pore; large in all but a few anteriormost segments. Holandric (funnels iridescent in X and XI); gymnorchous; seminal vesicles racemose in IX (?) and XII. Metagynous; ovisacs large, in XIV. Prostates depressed tubular with incised adpressed coils, in XVIII–XX; vas deferens joining the gland shortly ental to the muscular duct. Penial setae (holotype) filiform; tip pointed and slightly upturned; no ornamentation; length = 0·76 mm. Spermathecae 3 pairs, decreasing in size anteriorly; diverticulum (uninseminated) single, clavate uniloculate.

MATERIAL EXAMINED.

Tunnack, under logs and stones, damp conditions, 147°30′E. 42°25′S. Map, 14/2, Dr J. L. Hickman, 18 Aug 1954 – holotype TM : K312; paratype BM(NH) : 1972.8.32.

REMARKS. As in all Tasmanian species of the genus, the genital markings of this species are distinctive. It is closest to *P.* (*V.*) *hobartensis* from which the 3 pairs of spermathecal pores are an additional distinction.

### ***Perionychella*** (subgenus ?) ***bassana*** (Spencer, 1895)

*Megascolides bassanus* Spencer, 1895 : 46–47, Pl. III, fig. 34–36.
*Plutellus bassanus*; Michaelsen, 1900 : 169; Jamieson, 1971c : 87.

l = 88 mm, w > 3 mm, s ?.

Prostomium prolobous. First dorsal pore in 4/5 (?). Setae 8 per segment. Nephropores in *c* lines. Clitellum saddle-shaped, embracing XIV–XIX, ventral

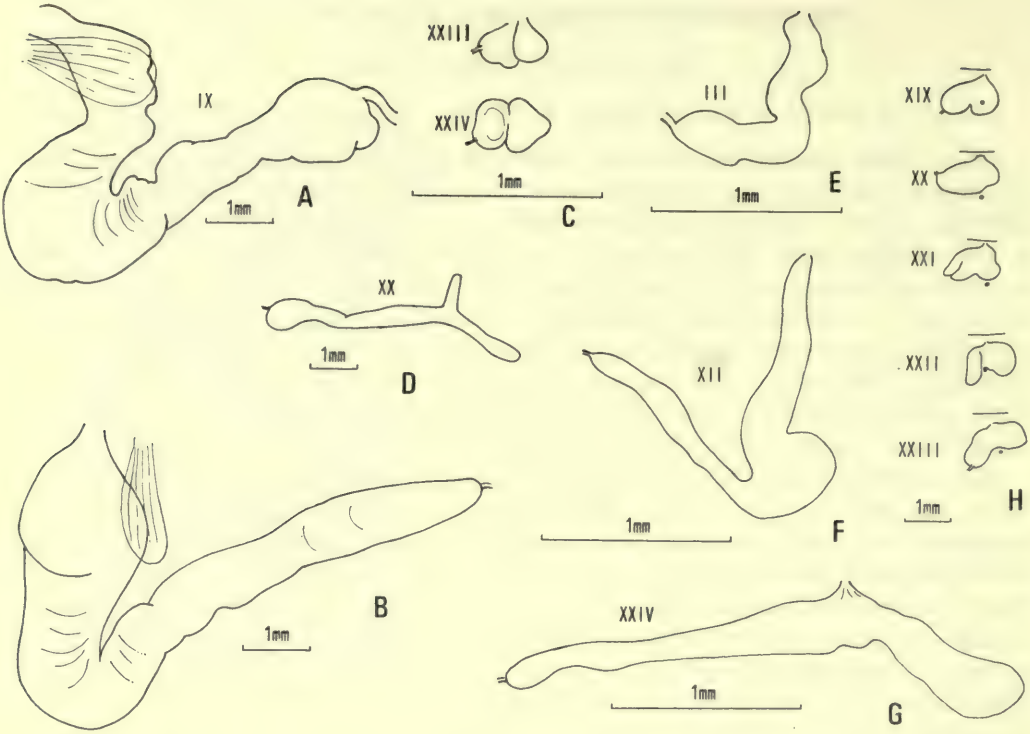


FIG. 15. Nephridial bladders in *Perionychella*. A & B, *Perionychella (Vesiculodrilus) hobartensis* : A, anterior segments ; B, an intestinal segment. C, *P. (V.) evansi*, holoytpe, D, *P. (V.) glandifera*, holotype. E–G, *P. (V.) mortoni*, 14/4, BM(NH) : 1972.8.18. H, *P. (V.) montisarthuri*, holotype, *in situ*, showing setae *c*. (A & B, left bladders ; others, right bladders.)

margins in *ab* excepting the anterior part of XIV, the whole of which is included. Male pores on papillae in XVIII in *a* lines. Accessory genital markings : a median ventral patch on each of XVII and XVIII ; and 2 papillae in XIX in *a* lines, conjoined by a median transverse ridge. Female pores on XIV within the tumid annular part of the clitellum near the midventral line. Spermathecal pores 2 pairs, in 7/8 and 8/9, in *ab*.

Dorsal blood vessel single ; last hearts in XIII ; no continuous supra-oesophageal. Gizzard in V. True calciferous glands absent but vascular swellings in XIII and XIV ; intestinal origin in XIX. Nephridia stomate holonephridia. Holandric ?, sperm funnels in X and XI. Seminal vesicles on anterior walls of X (?), XI and XII. Metagynous ; ovisacs ?. Prostates tubular, small and coiled, in XVIII. Spermathecae 2 pairs, in VIII and IX ; the diverticulum simple and less than half the length of the sac.

TYPE-LOCALITY. King Island in Bass Strait.

MATERIAL EXAMINED.

None. The types are missing from the National Museum of Victoria.

REMARKS. It is not entirely certain that this species should be assigned to *Perionychella*. The saddle-shaped clitellum is exceptional, and presence or absence of a typhlosole is not recorded, but otherwise nothing in the brief description excludes it from the genus.

### ***Perionychella*** (subgenus ?) ***decatheca*** (Michaelsen, 1910)

*Plutellus decatheca* Michaelsen, 1910 : 81–83, Fig. XIV–XVI ; Jamieson, 1971c : 87.

l = 100 mm, w = 10 mm, s = 164.

Prostomium epilobous ⅓, closed. First dorsal pore in 4/5. Setae widely paired ; in the forebody *aa* : *ab* : *bc* : *cd* : *dd* = 1·5 : 1 : 2 : 1·5 : 4·5 ; *dd* = 0·6*u* ; in the hindbody 1·5 : 1 : 1·3 : 1 : 2·5 ; *dd* = 0·25*u*. Clitellum annular, XIV–XVIII. Male pores on small papillae in XVIII, approximately in *ab*. Accessory genital markings : paired transverse almost linear papillae anterior and posterior to the male papillae, in XVII, XIX, XX and XXI extending medianly over *a* lines and laterally over *b* lines ; the markings on XVII much larger than those of XIX–XXI, almost contiguous medianly and nearly obscuring the male papillae. Female pores indicated by a long transverse furrow anteriorly in XIV. Spermathecal pores 5 pairs, in 4/5–8/9, in *a* lines.

Dorsal blood vessel single ; last hearts in XIII. A large gizzard in V. Calciferous glands absent ; oesophagus in XIV and XV appearing more vascular than elsewhere, but only slightly swollen. Holonephric. Holandric ; seminal vesicles racemose in IX and XII. Prostates tubular ; duct short and thin. Penial setae ca. 1·2 mm long, and 18 μm thick, almost straight, proximally slightly curved, distally only slightly tapered. Distal tip rather stout, bent into a small hook. Distal end of the seta ornamented with wide deep teeth, which project very steeply from the seta ; the teeth lying in 4 fairly regular spirally arranged lines. Spermathecae with single, clavate, uniloculate diverticulum.

TYPE-LOCALITY. The vicinity of Hobart.

MATERIAL EXAMINED.

None.

REMARKS. Michaelsen considered *P. decatheca* to be close to *P. insularis* (Spencer, 1895) which is now a junior synonym of *P. hobartensis*. Possibly *decatheca* is merely a variant of the sympatric *hobartensis* but differences from the latter, *viz.* setal rather than intersetal accessory genital markings and the form of the penial setae preclude union of the two taxa on present information. Location of the genital markings anteriorly rather than posteriorly in their segments and apparently the form of the penial setae exclude *decatheca* from the similarly sympatric and not dissimilar *P. mortoni*. Known only from the holotype.

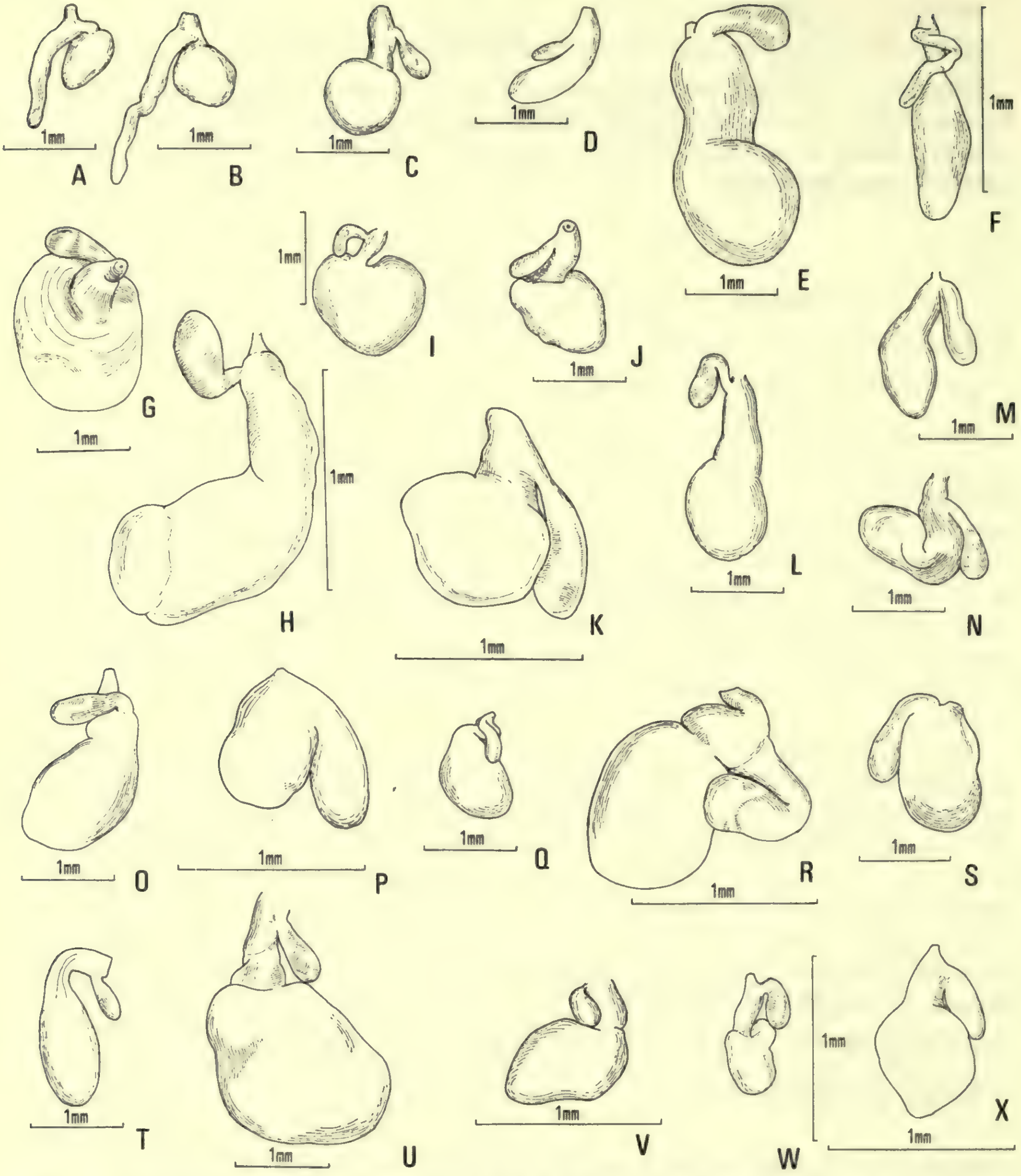

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FIG. 16. Spermathecae in *Perionychella*. A & B, *Perionychella* (*P.*) *capensis* : A, holotype (left IX) ; B, paratype 1 (left IX). C & D, *P.* (*P*). *hickmani* : C, holotype (right IX) ; D, paratype 3 (right VIII). E, *P.* (*P.*) *kershawi*, holotype (right VIII). F, *P.* (*P.*) *weldboroughi*, holotype (right IX). G, *P.* (*P.*) *irregularis*, lectotype (left IX). H, *P.* (*V.*) *bithecata*, holotype (left IX). I, *P.* (*V.*) *lacustris*, TM : K265 (left IX). J, *P.* (*V.*) *dilwynnia*, 13/4, TM : K266 (right IX). K, *P.* (*V.*) *evansi*, holotype (right IX). L & M, *P.* (*V.*) *glandifera* : L, holotype (left IX) ; M, paratype (right IX). N & O, *P.* (*V.*) *hellyeri* : N, paratype 2 (right IX) ; O, holotype (right VIII). P–R, *P.* (*V.*) *hobartensis* :

## **Perionychella** (subgenus ?) **ellisi** (Spencer, 1895)

Fig. 1.

*Cryptodrilus ellisii* (sic) Spencer, 1895 : 42–43, Pl. 2, fig. 22–24.
*Plutellus ellisi* ; Michaelsen, 1900 : 172 ; Jamieson, 1971c : 87.

l = 25–38 mm, w = 3 mm, s ?.

Prostomium epilobous ½, it and the body canaliculate. First dorsal pore in 5/6. Setae 8 per segment throughout ; *bc* ≑ *cd* ≑ *dd*. Clitellum annular, XIV–XVI or posterior XIII also. Male pores in XVIII in *b* or perhaps slightly ventral of this, on papillae. Accessory genital markings : paired elliptical patches in *ab* anteriorly in X and XI ; in 17/18 and 18/19 and anteriorly in XX and XXI. Female pores anteromedian of setae *a* of XIV. Spermathecal pores 3 pairs, in 6/7–8/9, in *b* lines. Last hearts in XII. Gizzard in V. Sessile paired dorsolateral calciferous glands in XIV and XV. Intestinal origin in XVII. Holonephric. Holandric ; seminal vesicles racemose, in IX and XII. Prostates tubular, coiled, in XVII–XX. Metagynous ; ovisacs in XIV. Spermathecae 3 pairs ; diverticulum short, simple.

TYPE-LOCALITY. Dee Bridge, under logs and stones, 146°35′E. 42°15′S. Map, 13/7.

MATERIAL EXAMINED.

The four syntypes (NMV : G32) were found to be in poor condition and no longer yield useful information.

## **Perionychella** (subgenus ?) **moroea** (Spencer, 1895)

Fig. 1.

*Perichaeta moroea* Spencer, 1895 : 49, Pl. IV, fig. 40–42.
*Diporochaeta moroea* ; Michaelsen, 1900 : 207 ; Jamieson, 1971c : 83.

l = 100 mm, w ?, s ?.

Prostomium very slightly epilobous. First dorsal pore in 3/4. Preclitellar setae 11–18 on each side ; intraclitellar and postclitellar setae 21 per side ; dorsal and ventral breaks very small. Nephropores in setal lines 9 or 10 in the midbody. Clitellum ? Male pores on papillae between setal lines 3 and 4. Accessory genital markings : median ventral ridge on XVIII between the male papillae ; a pair of elliptical patches in *ab*, in 19/20 (or 18/19 ?). Female pores on XIV. Spermathecal pores 2 pairs, in 7/8 and 8/9, in *ab*.

Last hearts in XII ; supra-oesophageal present. Gizzard in V. True calciferous glands absent. Intestinal origin XVII. Holandric ; seminal vesicles racemose, in

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P, lectotype (right IX) ; Q, 14/1, TM : K294 (right IX) ; R, 14/6, BM(NH) : 1972.8.15 (right IX). S, *P.* (*V.*) *montisarthuri*, holotype (right IX). T, *P.* (*V.*) *mortoni*, 14/4, BM(NH) : 1972.8.18 (right IX). U & V, *P.* (*V.*) *obliquae* : U, holotype (right IX) ; V, 17/1, AM : W5202 (right IX). W, *P.* (*V.*) *pedderensis*, holotype (right VIII). X, *P.* (*V.*) *tunnackensis*, holotype (right IX).

IX and XII. Metagynous. Ovisacs absent? Prostates in XVII–XX. Spermathecae 2 pairs; diverticulum simple.

TYPE-LOCALITY. Lake St Clair, 146°10′E. 42°05′S. Map, 13/5.

MATERIAL EXAMINED.

The single type-specimen (NMV : G292) is in a very refractory condition and yields no useful information.

REMARKS. There is a discrepancy in Spencer's account: genital markings are paired in 19/20 according to the text but in 18/19 in the illustration. If the markings were in 19/20 there is a possibility that *P.* (*P.*) *capensis* (from Table Cape) is a junior synonym. Both species are perichaetine. Differences from *capensis* indicated by Spencer's account are location of the spermathecal pores in *ab* (not *c*), absence of accessory genital markings in 17/18 and intestinal origin in XVII (not ½XVI). These differences, if real, appear to warrant specific distinction of *capensis* but confirmation of the distinctness of the two entities must await collection of new material of *moroea*.

*P.* (*V.*) *evansi* from the same locality as *moroea* has, like the latter and *capensis*, 2 pairs of spermathecae. It differs from *moroea* in having lumbricine setae, in the genital fields and in other respects and conspecificity is not indicated.

### ***Perionychella*** (subgenus ?) ***richea*** (Spencer, 1895)

Fig. 1.

*Perichaeta richea* Spencer, 1895 : 49–52, Pl. V, fig. 49–51.
*Diporochaeta richea*; Jamieson, 1971c : 83.

l = 75 mm, w = 3 mm, s ?.

Epilobous ½. First dorsal pore in 3/4. Setae 12 on each side anterior to clitellum, 24 half-way along the body. Clitellum annular, XIV–XVII. Male pores on papillae in *ab*. No accessory genital markings developed. Female pores on XIV. Spermathecal pores 5 pairs, on small elliptical patches at the posterior margins of IV–IX, in *a*.

Last hearts in XII; supra-oesophageal in IX–XII. Gizzards in III and IV (?). No true calciferous glands but oesophagus in XI and XII white and swollen. Intestinal origin XVII. Holonephric. Holandric; seminal vesicles racemose, in IX and XII. Metagynous; ovisacs in XIV. Prostates wide, tubular, in XVII–XIX. Spermathecae 5 pairs; the diverticulum very small.

TYPE-LOCALITY. Mount Olympus, under logs in the Beech forest, 146°10′E. 42°05′S. Map, 13/5.

MATERIAL EXAMINED.

None available.

REMARKS. Reported location of gizzards in III and IV, if accurate, would be highly distinctive but this position is very questionable as it is unknown elsewhere in the suborder Lumbricina. This species must be regarded as a *species dubium* as, apart from the dubious location of the gizzards, there is nothing distinctive in the description which would permit identification. The types are no longer traceable in the Spencer collection (Jensz and Smith 1969).

### ***Perionychella*** (subgenus ?) ***scolecoidea*** (Spencer, 1895)

Fig. 1.

*Perichaeta scolecoidea* Spencer, 1895 : 51–52, Pl. V, fig. 47–51.
*Diporochaeta scolecoidea* ; Michaelsen, 1900 : 207 ; Jamieson, 1971c : 83.

l = 25–27 mm, w = 5 mm, s = 72–77 (lectotype and 2 paralectotypes).

Form very wide relative to the short length. Prostomium epilobous $< \frac{1}{2}$. First dorsal pore in 3/4 (Spencer). Setae 35 on each side in IV and caudally ; 40–44 on each side in XX ; no dorsal gap throughout ; some ventral interruption posteriorly but irregular and slight (paralectotype 1). Nephropores and clitellum not visible. Male pores on minute papillae in setal lines 4 in XVIII. Accessory genital markings an indistinct transverse pad extending laterally as far as setal line 6 in each of intersegments 13/14 and 14/15 (lectotype and paralectotype 1 ; none recorded in the text by Spencer but a median pad illustrated in 19/20). Female pores just in front of setae *b* of XIV. Spermathecal pores 2 pairs, in 7/8 and 8/9, in or slightly lateral of setal lines 3 (lectotype) ; or in s.l. 4 (Spencer).

Dorsal vessel single ; last hearts in XII (confirmation). Supra-oesophageal vessel in VIII–XII (Spencer). Gizzard very large, but not very thick walled, in V (confirmation) ; true calciferous glands absent ; intestinal origin XVIII (Spencer).

Holonephric ; nephridia more coiled in II–V than elsewhere. Holandric ; seminal vesicles racemose, in XII. Metagynous (Spencer). Prostates racemose, depressed and lobed, in XVIII (confirmation from lectotype). Penial setae absent (lectotype). Spermathecae 2 pairs, in VIII and IX, each with 2 very small diverticula at the base of a fair-sized sac (Spencer).

TYPE-LOCALITY. King River Valley, approximately 145°25′E. 42°10′S. Map, 12/1.

MATERIAL EXAMINED.

Lectotype NMV : G290 and 2 paralectotypes, G1422.

REMARKS. The material examined was refractory and yielded little information. The condition of the nephridial ducts was indeterminable.

## Genus ***GRALIOPHILUS*** Jamieson, 1971e

DIAGNOSIS. Combined male and prostatic pores a pair on XVIII. Prostates tubular. Setae 8 per segment ; $cd \doteqdot 0{\cdot}7\text{–}1{\cdot}3bc$. Nephridia exonephric, stomate, avesiculate holonephridia forming a single series on each side discharging in *c* or *d* or above these; sometimes replaced in a varying number of anterior segments by coiled or tufted nephridia with anteriorly directed (always buccal ?) ducts. Calciferous glands and intestinal typhlosole present or absent. Spermathecae 2 or less commonly 3 pairs with extramural diverticula, sometimes with sperm chambers in the walls but never multiloculate.

TYPE-SPECIES. *Graliophilus georgei* Jamieson, 1971e.

DISTRIBUTION. Western Subregion of Australia, South Western faunal province. Eastern Subregion, New South Wales (Mt Kosciusko) ?, Tasmania ?.

REMARKS. The above generic diagnosis is based on Jamieson, 1971e. *Graliophilus* was erected for Western Australian species which previously would have been ascribable to *Plutellus* but clearly were not congeneric with the type-species of that genus nor with species of any other genera erected during progressive revision of *Plutellus*. The two species from New South Wales (*G. montiskosciuskoi* and *G. woodi* Jamieson, 1973a), were referred tentatively to *Graliophilus* but the widening of *Perionychella* to include avesiculate and vesiculate, lumbricine and perichaetine species, permits *G. montiskosciuskoi* to be placed unequivocally in *Perionychella* as a lumbricine species of the nominate subgenus. *G. woodi* and the Tasmanian species *G. tripapillatus* sp. n. differ from *Perionychella* as currently defined in possessing true typhlosoles. Typhlosoles are present in some Western Australian species of *Graliophilus* and *woodi* and *tripapillatus* have therefore been referred to this genus, with which they conform in general morphology, though the identification is made with considerable hesitation. It must be noted that in another Tasmanian genus, *Cryptodrilus*, typhlosoles may be present or absent in closely related species and that separation of *woodi* and *tripapillatus* from *Perionychella* may, therefore, be unnatural as no other significant features are known to exclude them from the latter genus. Furthermore, *P.* (*P.*) *capensis* has a slight dorsal intestinal ridge which might be considered a rudimentary typhlosole.

This difficulty in generic identification of species reflects that fact that distinction of *Graliophilus* from *Perionychella* is rendered uncertain by the emendment of *Perionychella*. While some Western Australian species groups, notably the *strelitzi*-group of *Graliophilus*, are unquestionably distinct from *Perionychella*, the *georgei*-group, containing the type-species of *Graliophilus*, conforms closely in morphology with the emended *Perionychella*. However, in Western Australian *Graliophilus* species the number of spermathecae is less (2 or 3 pairs) than the 5 pairs usual in *Perionychella* (though some species of the latter have 1–4 pairs) and the avesiculate and totally lumbricine condition is constant whereas the combination of these characters is known in no *Perionychella* species from Victoria or New South Wales and in only one, *P.* (*P.*) *weldboroughi*, from Tasmania. Wallace (1972) has shown that species since placed by the author in *Perionychella* show only a low phenetic resemblance to *Graliophilus* species when affinity is assessed from large character-sets using computer techniques. It is hoped that analysis of the data will allow diagnosis of each genus from the other without recourse to numerical methods.

In short, the following Tasmanian species referred to *Graliophilus* may be a typhlosolate species of *Perionychella* (*Perionychella*).

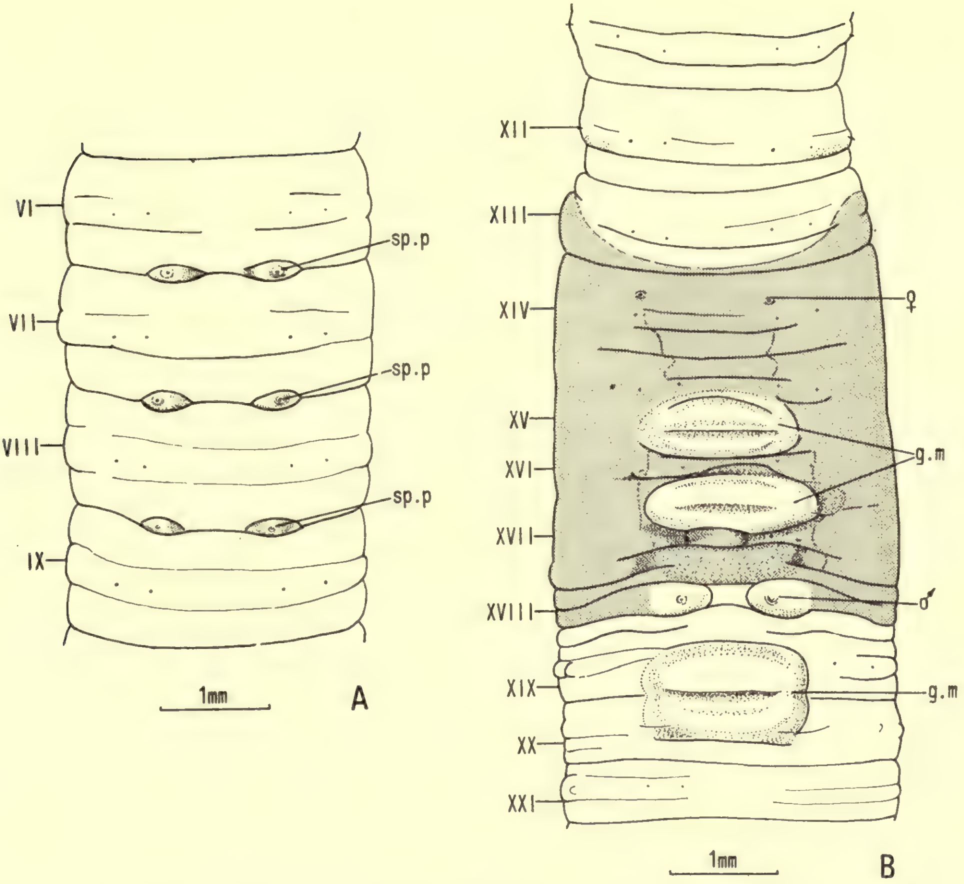

FIG. 17. Genital fields. *Graliophilus tripapillatus*, holotype : A, spermathecal field ; B, male field.

## ***Graliophilus*** **(?)** ***tripapillatus*** sp. n.

Fig. 4, 17, 32A ; Plate 1. Table 3

l = 60, 59 mm, w = 3·2, 3·0 mm, s = 130, 135.

Prostomium epilobous ⅓, closed. Dorsal pores not visible. Setae 8 per segment, in regular longitudinal rows throughout. Nephropores in *c* lines. Clitellum annular, ½XIII–½XVIII. Male pores on XVIII in *a* on dome-shaped papillae reaching from *b* to an approximately equal distance median to the pores. Accessory genital markings midventral unpaired transverse pads in 15/16, 16/17 and 19/20, extending laterally into *ab* or beyond *b* and longitudinally to or over the setal rows of adjacent segments ; the pads increasing in size and prominence posteriorly ; faintly indicated glandular and slightly tumid interruptions of the intersegments, in 17/18 and 18/19. Female pores paired on XIV, anterior and only slightly median to setae *a*. Spermathecal pores 3 pairs, in 6/7–8/9, on small papillae in *a*.

TABLE 3

Intersetal distances in segment XII in *Graliophilus tripapillatus*

| | mm | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | *aa* | *ab* | *bc* | *cd* | *dd* | *dc* | *cb* | *ba* |
| holotype | 0·9 | 0·4 | 1·0 | 0·6 | 3·3 | 0·6 | 1·0 | 0·4 |
| paratype 1 | 0·7 | 0·4 | 0·9 | 0·7 | 2·7 | 0·6 | 0·8 | 0·4 |
| paratype 2 | 1·1 | 0·4 | 1·0 | 0·6 | 3·6 | 0·6 | 1·0 | 0·4 |
| paratype 3 | 1·3 | 0·4 | 1·0 | 0·6 | 3·8 | 0·6 | 1·0 | 0·4 |
| paratype 4 | 1·0 | 0·5 | 0·9 | 0·6 | 2·8 | 0·6 | 0·9 | 0·4 |
| | standardized ($u$ = 100) | | | | | | | |
| | *aa* | *ab* | *bc* | *cd* | *dd* | *dc* | *cb* | *ba* |
| holotype | 11·35 | 4·80 | 11·79 | 7·42 | 49·61 | 7·42 | 11·79 | 4·80 |
| paratype 1 | 10·40 | 4·95 | 12·87 | 9·41 | 38·61 | 7·92 | 10·89 | 4·95 |
| paratype 2 | 12·55 | 4·86 | 11·34 | 6·88 | 41·30 | 6·88 | 11·34 | 4·86 |
| paratype 3 | 13·96 | 4·53 | 11·32 | 6·79 | 40·75 | 6·79 | 11·32 | 4·53 |
| paratype 4 | 12·44 | 5·99 | 11·98 | 8·29 | 36·87 | 7·37 | 11·98 | 5·07 |
| mean | 12·14 | 5·03 | 11·86 | 7·76 | 39·63 | 7·28 | 11·46 | 4·84 |
| interval/*ab* | 2·41 | 1·00 | 2·36 | 1·54 | 7·88 | 1·45 | 2·28 | 0·96 |

Last hearts in XII (latero-oesophageal) ; supra-oesophageal moderately developed in VIII–XIII. Gizzard large and firm in V. Calciferous glands absent ; oesophagus internally rugose and with circumferential vascular striae in VIII–XVI. Intestinal origin XVIII ; deep dorsal typhlosole commencing in XX. Nephridia simple stomate, avesculate, exonephric holonephridia (funnels demonstrated in fore- and mid-body) ; ducts entering the parietes presetally in *c* lines, in the forebody forming wide-tubes but not sufficiently dilated to be termed bladders ; slender in the midbody.

Holandric (funnels iridescent in X and XI) ; gymnorchous ; seminal vesicles racemose, in IX and XII. Metagynous ; ovisacs in XIV. Prostates much coiled, depressed tubular ; vas deferens joining the sinuous ectally widening duct shortly ectal of the gland. Penial setae very slender, tip bifid, chelate, the two branches terminally contiguous, a coarse tooth, almost large enough to be considered a bifurcation, on one branch ; ornamentation absent ; length ? mm, general width of shaft = 3 $\mu$m (holotype). Spermathecae 3 pairs ; diverticulum (inseminated) single, clavate, uniloculate.

*Genital markings.* Of the 15 type-specimens (holotype, paratypes 1–14) only the holotype and paratype 1 have the genital marking in 15/16. Otherwise the genital fields are invariable in all specimens, with median genital marking in each of intersegments 16/17 and 19/20 and, less strongly indicated, in 17/18 and 18/19.

MATERIAL EXAMINED.

Tarraleah, over pipeline, 146°25′E. 42°20′S. Map, 13/4, Dr J. L. Hickman, 27 May 1954 – holotype TM : K313 ; paratypes 2–6 TM : K314–318 ; paratypes 1, 7–9 BM(NH) : 1973.2.1–4 ; paratypes 10–12 AM : W5203–5205 ; paratypes 13 and 14 BJ : T23–24.

REMARKS. The genital field, with its arrangement of three genital markings, diagnoses this species.

## Genus ***PINGUIDRILUS*** gen. nov.

DIAGNOSIS. Setae 8 per segment. Combined male and prostatic pores a pair on XVIII. Prostates a single pair, tubular. Gizzard in V and VI ; extramural calciferous glands and intestinal typhlosole absent. *Nephridia vesiculate holonephridia discharging irregularly in* c *to near middorsum. Spermathecae adiverticulate.*

DESCRIPTION. Large ; terrestrial. Dorsal pores present. Setae 8 per segment. Nephropores erratically in *c* to near the middorsal line. Clitellum long (> 9 segments), including the male pores. Male pores (combined pores of the vasa deferentia and the single pair of prostates) on XVIII. Female pores paired on XIV. Spermathecal pores 5 pairs, the last in 8/9. Accessory genital markings present in the vicinity of the male pores.

Last hearts in XIII, latero-oesophageal hearts, in X–XIII, with connectives to dorsal and the supra-oesophageal vessel. Gizzard large, in V–VI. Extramural calciferous glands absent ; intestinal origin XIX ; typhlosole absent. Nephridia simple, exonephric holonephridia with large ectal bladders. Holandric ; gymnorchous ; seminal vesicles in IX and XII. Metagynous ; ovisacs absent. Prostates slightly lobulated tubes. Penial setae absent. Spermathecae lacking diverticula.

DISTRIBUTION. Tasmania. (Monotypic.)

TYPE-SPECIES. *Notoscolex tasmanianus* Fletcher, 1888b.

REMARKS. *Pinguidrilus* retains the primitive holonephric condition (two nephridia per segment) seen elsewhere in Tasmania only in *Rhododrilus* (Acanthodrilinae) and in *Perionychella* and a doubtful member of each of the genera *Graliophilus* and *Woodwardiella* (Megascolecinae). The italicized features in the above diagnosis distinguish it from all these genera. Its closest phyletic relationship is presumably with the similarly vesiculate *Perionychella* (*Vesiculodrilus*) but the absence of spermathecal diverticula is a very rare condition in the Megascolecidae (with the exception of the Ocnerodrilinae, in which diverticula are only exceptionally present) and, with the unusual arrangement of the nephropores, suggests a rather isolated position for the genus. This irregular disposition of the nephropores is also seen in the Nearctic plutelloid genus *Argilophilus*, which shows strong morphological affinities with *Pinguidrilus*, though avesiculate and possessing spermathecal diverticula albeit little more than sperm chambers in the wall of the spermathecal duct.

### ***Pinguidrilus tasmanianus*** (Fletcher, 1888b)

Fig. 4, 25B, 32B

*Notoscolex tasmanianus* Fletcher, 1888b : 607–611.
*Megascolides tasmanianus* ; Spencer, 1895 : 33.
*Plutellus tasmanianus* ; Michaelsen, 1900 : 175 ; Jamieson, 1971c : 88.

l = ?, w = 23 mm, s = ?.

Circular in cross section, segments I and II simple ; thereafter, in the forebody, strongly triannulate. Prostomium epilobous, closed, ½ ; it and the peristomium with numerous longitudinal grooves. First dorsal pore in 10/11, minute. Setae 8 per segment but *c* and *d* only sporadically visible ; setae *a* and *b* absent in XVIII. Nephropores (see nephridia, below). Clitellum annular, strongly protuberant, embracing XIV–⅓XXIII ; dorsal pores absent, intersegmental furrows retained only ventrally ; ventral setal couples visible ; nephropores not visible. Male pores distinct but minute apertures in *ab* on small white papillae which occupy the setal annulus of XVIII. Genital markings 7 median transverse pads, in intersegmental furrows 14/15–20/21, each bisected by the furrow, longitudinally occupying the posterior and anterior annuli of the adjacent segments, and extending laterally beyond setal lines *b* ; those in 17/18 and 18/19 not as extensive transversely as the others and only shortly overreaching *b* lines. Female pores a pair of minute orifices on small, low papillae, on XIV, very shortly anteromedian of setae *a*, on the setal annulus. Spermathecal pores on 5 pairs of small, round papillae, in 4/5–8/9, in *a* lines.

Septa progressively thickened from 3/4 to 12/13 ; 3/4 and 4/5 obscured by tendons running to the next posterior septa ; 5/6 strong ; 12/13 immensely thick ; 13/14 moderately thick ; the remainder thin. Dorsal blood vessel single ; continuous onto the pharynx. Dorsoventral commissural vessels in V–XIII ; those in X–XIII forming 4 pairs of latero-oesophageal hearts ; those in IX anteriorly progressively more slender and dorsoventral only. Each latero-oesophageal heart receiving a slender connective from the dorsal vessel and a thicker connective from the median supra-oesophageal vessel immediately behind the junction with the latter of a pair of vessels from the oesophageal wall. Supra-oesophageal beginning (very thin) anteriorly in VIII and ending posteriorly as the connectives to the hearts in XIII, the vessel well defined and separate from the oesophagus throughout and posteriorly almost as thick as the dorsal vessel ; receiving vessels from the oesophagus throughout its course. Gizzard large and muscular but fairly easily compressible, in V and VI, septum 5/6 being inserted on its equator where the commissures of V join the dorsal vessel. Oesophagus in VII long, coiled and muscular ; in VIII–XI vascular, though not conspicuously, and not dilated ; in XII and XIII segmentally dilated and with numerous circumferential vascular striae ; in XIV–XVIII very wide, extremely thin walled and vascular, giving paired vessels directly to the dorsal vessel. Intestine commencing in XIX ; no typhylosole detectable.

Nephridia : nephropores erratically positioned (described by Fletcher as an irregularly sinuous series varying from *c* lines to near the middorsal line) ; their position sometimes corresponds with setal loci but these also are erratic. In the intestinal region nephridia are stomate, vesiculate holonephridia without supplementary loops ; vesicles are large, in two wide sections with a narrow section between ; a slight angular projection which could be regarded as a diverticulum extends laterally beyond the position of opening ; no change in structure occurs at the hind end ; anteriorly nephridial structure is similar but the vesicle is not distinctly divided into two parts (Wallace, personal communication). Testes ? sperm masses and large funnels free in X and XI. Seminal vesicles large and racemose in IX and XII ; approximately equisized. Ovaries paddle-shaped, with many rows of minute oocytes, and small funnels in XIII. Prostates restricted to XVIII, slender tortuous tubes with slightly lobulated surfaces ; the slender ducts receiving the vasa deferentia near the junction with the glandular portions. Penial setae absent. Spermathecae 5 pairs of simple pouches tapering to the pores but lacking distinctly differentiated ducts ; diverticula absent.

TYPE-LOCALITY. Thomas' Plains, N.E. Tasmania.

MATERIAL EXAMINED.

A single fragmenting clitellate specimen labelled 'Megascolides tasmanicus [*sic*] Fletcher jar 2', Baldwin Spencer collection, ex Melbourne University Zoology Department, May 1968.

REMARKS. The above description agrees closely with that of Fletcher and, as the material of Fletcher species in the Baldwin Spencer collection must be considered type material, the specimen examined is here designated the lectotype NMV : G2112. The following additional data are given by Fletcher : lengths (contracted) 200–250 mm, width 19–24 mm ; about 200 segments. Setal lines *d* sinuous ; *aa* : *ab* : *bc* : *cd* = 4 : 2 : 4 : 3–8. The first dorsal pore was observed in 12/13, and the clitellum on ½XIII–XXII ; the gizzard in V ; the oesophagus dilated and vascular in VIII–XVI and especially in XIII–XVI, showing effervesence in acid in all but the first segment.

## Genus ***WOODWARDIELLA*** Stephenson, 1925

DIAGNOSIS. Combined male and prostatic pores a pair on XVIII. Prostates racemose. Setae 8 per segment ; *cd* ≑ or slightly > *bc*. Nephridia exonephric, stomate, avesiculate holonephridia forming a single series on each side in *c* lines but (always ?) replaced in anterior segments by tufts discharging into the buccal cavity or exonephrically in *d* lines. Calciferous glands absent ; typhlosole weakly developed or absent. Spermathecae 2 pairs, diverticulum simple, not multiloculate. (Based on Jamieson (1970, 1971e).)

TYPE-SPECIES. *Woodwardia callichaeta* Michaelsen, 1907a.

DISTRIBUTION. South-western Australia. Tasmania ? Victoria ?

REMARKS. Differences between *Woodwardiella* and the older genus *Perionychella* require augmentation. The prostates in *Perionychella* are tubular or, if externally racemose, retain an axial lumen whereas those of *Woodwardiella* have a typical *Pheretima*-type prostate with branching internal ducts (Michaelsen, 1916). Although this difference is allowed in *Cryptodrilus*, a genus in which species with the two alternative conditions of the prostates are assignable to the same genus by virtue of the peculiar excretory system which they share, it warrants separation of *Woodwardiella* and *Perionychella* pending further investigation of the former little known genus. Tubular prostates are all that is certainly known to distinguish *Graliophilus* from the older *Woodwardiella* and further investigation of the justification of retaining *Graliophilus* as a separate genus from *Woodwardiella* or *Perionychella* is also required.

The following Tasmanian species was transferred to *Woodwardiella* by Jamieson (1971c) from the artificial congeries *Plutellus*, in which Michaelsen (1900) had placed it on the then justified grounds that it had 8 setae per segment, holonephridia and apparently racemose prostates. As no material of it is available for the present study it is retained in *Woodwardiella* though it appears likely that its prostates will be found to be tubulo-racemose and that it will be assignable to *Perionychella*.

### ***Woodwardiella* ? *tessellatus* (Spencer, 1895)**

Fig. 4

*Cryptodrilus tesselatus* (sic) Spencer, 1896 : 40–41, Pl. II, fig. 16–18.
*Plutellus tessellatus* ; Michaelsen, 1900 : 170–171.
*Woodwardiella* ? *tesselatus* ; Jamieson, 1971c : 92.

l = 25 mm, s = 65.

Prostomium slightly epilobous. First dorsal pore in 5/6. Setae 8 per segment, the dorsal row very irregular and setae *d* absent in some segments ; *c* regular except caudally. Clitellum annular, XIII–XVII, with midventral continuation in *bb* in XVIII and XIX. Male pores on small papillae in XVIII, in *ab*. Accessory genital markings 2 pairs of small elliptical patches in 12/13 and 13/14 in *ab*. Female pores anteromedian to setae *a*, at $\frac{1}{3}$*aa*, in XIV. Spermathecal pores 2 pairs, in 7/8 and 8/9, in *ab*.

Last hearts in XII. Gizzard in V ; true calciferous glands absent ; intestinal origin XVII. Holonephric. Holandric ; seminal vesicles saccular, in XII. Metagynous. Prostates small flattened lobes, in XVIII. Spermathecae 2 pairs, in VIII and IX ; diverticulum simple, less than half the length of the ampulla.

TYPE-LOCALITY. Mount Olympus, Lake St Clair, in damp soil under logs, and amongst decaying leaves in beech forest. Map, 13/5.

MATERIAL EXAMINED.

None available.

## Genus ***CRYPTODRILUS*** Fletcher, 1887a emend.

DIAGNOSIS. A pair of combined male and prostatic pores on the seventeenth setigerous segment, normally XVIII. Setae 8 per segment. Meronephric ; nephridia typically vesiculate, frequently avesiculate, throughout, not very numerous on each side, some or all discharging in the setal lines ; the medianmost nephridium usually (always ? ) with preseptal funnel. Typhlosole present or absent. Prostates tubular, tubuloracemose, or racemose.

DESCRIPTION. Moderate-sized earthworms with less than 200 segments. Prostomium zygolobous to tanylobous. Dorsal pores present or absent. Setae in 8 regular longitudinal lines, commencing on II (or, *C. mediocris*, on the product of union of the first and second metameres). Ventral setal couples widely paired (*aa* ≑ 1·5–3*ab*) ; setae of the dorsal couples (*cd*) widely separated, always further apart than those of the ventral couple (*cd* ≑ 2–4*ab*) and usually a greater interval, sometimes smaller, than the interval between the couples of a side (*bc*) ; dorsal median intersetal distance (*dd*) ≑ 0·2–0·4 of the circumference (*u*). Setae *a* and *b* absent in the segment bearing the male pores ; usually replaced by penial setae. Nephropores (conspicuous or not) at least 3 on each side in some segments and reaching (*C. polynephricus*) as many as 10 per side ; the pores associated with some or all four of the setal lines where the number per side is 4 or less ; increase in number intersetal and setal. Clitellum annular, commencing in XII–XIV and including or shortly preceding the segment bearing the male pores. A pair of combined male and prostatic pores on XVIII (or XVII where intersegment 1/2 is suppressed), in *b* or median of this. Accessory genital markings present. Female pores a pair, or unpaired midventral, in XIV, inconspicuous, though sometimes in a common glandular field. Spermathecal pores 2 or 3 pairs, the last pair in intersegmental furrow 8/9.

Some preclitellar septa strongly thickened. Gizzard rudimentary to well developed, in V. Definite calciferous glands absent but oesophagus in some segments vascularized, often dilated, and internally rugose or lamellate. Intestinal origin XVI, XVII or XVIII ; typhlosole present or absent. Dorsal blood vessel (always ?) continued onto the pharynx ; dorsoventral commissurals commencing in V or further posteriorly ; last hearts in XII or XIII, those in X–XIII forming latero-oesophageal hearts with connectives from the supra-oesophageal vessel and in some species from the dorsal vessel. Supra-oesophageal vessel not extending more than a segment or two in front of the latero-oesophageal hearts. Subneural vessel absent. Nephridia 3–ca. 15 exonephric nephridia on each side, typically vesiculate but frequently avesiculate, some or all discharging in the setal lines ; the medianmost nephridium in the intestinal or at least caudal region stomate in most if not all species and frequently enlarged as a megameronephridium ; posterior nephridia sometimes sending ducts posteriorly through several segments or sometimes with the stomate nephridia contributing to a longitudinal excretory duct (ureter) which appears to discharge at junction of rectum and body wall ; rarely (*C. enteronephricus*) with duct of each stomate megameronephridium entering the intestine. Avesiculate exonephric or enteronephric tufts present or absent in anterior segments. Holandric ; gymnorchous ; seminal vesicles in 2 or more of segments IX, X, XI and XII. Metagynous ; ovisacs present or absent. Prostates one pair, racemose, with branched internal and external ducts, or tubuloracemose (lobulated but with single central lumen which (always ?) has side branches) ; vasa deferentia joining the ectal end of the gland or the prostate duct shortly ectal of this. Spermathecae discharging anteriorly in their segments ; the duct with one or two uniloculate diverticula.

TYPE-SPECIES. *Cryptodrilus rusticus* Fletcher, 1887a.

DISTRIBUTION. Eastern Subregion of Australia, Southern faunal province : New South Wales and Victoria. Tasmania.

REMARKS. The tribe Perionychini was established by Jamieson (1971a) for those Megascolecinae which were holonephric, or had meronephridia in a varying number of segments anterior to holonephridia, and which lacked intestinal enteronephry. Demonstration of more than two vesiculate nephridia per segment in *Cryptodrilus* (*vide* Jamieson 1972b) posed the problem that this genus could not be placed in any one of the three megascolecine tribes (Perionychini, Dichogastrini and Megascolecini) recognized by the author but studies of general morphology, and a numerical (taxonometric) investigation of setal ratios, suggested that the affinities of *Cryptodrilus* lay with the Perionychini. An evolutionary pathway for origin of the multiple-bladder condition from the holonephric vesiculate condition exemplified by *Plutellus heteroporus*, the 'heteropore' condition, was suggested. It was pointed out, and is still maintained, that recognition of a tribe Cryptodrilini to include *Cryptodrilus* deserves consideration. In the present work *Cryptodrilus* is included in the Perionychini because of its close morphological and presumed evolutionary links with this tribe, the nephridial bladders, which are unknown in the Dichogastrini and Megascolecini, being an especially significant indication of affinity. Pending the possibility of erection of a tribe Cryptodrilini, then, the definition of the Perionychini must be enlarged to include species with multiple bladders in a segment or, in other words, all megascolecine species with nephridial bladders, irrespective of whether holonephric or meronephric, in addition to holonephric avesiculate species.

Some species of *Cryptodrilus*, which have clear affinities (sometimes at the infraspecific level) with vesiculate species, lack nephridial bladders. They have median stomate nephridia in posterior segments, as do some vesiculate species, and are presumed to represent an acquisition of the dichogastrin condition of nephridia independently of the true Dichogastrini. This view is preferred to the alternative that they represent a survival of populations transitional between the Perionychini and Dichogastrini as the numerical study indicated that, at least in setal ratios, the Dichogastrini are distinct from the Perionychini. This distinctness might have been developed subsequent to origin of Dichogastrini from populations of which Tasmanian perionychines are representative but variation from the vesiculate to the avesiculate condition infraspecifically, or at least in very closely related subgeneric taxa (vide *C. polynephricus*), indicates that loss of vesicles is currently occurring in Tasmanian perionychines. The definition of the Perionychini must, therefore, be further extended to allow inclusion of forms which have acquired the dichogastrin condition but have clear relationships with perionychin species. In addition, an avesiculate species, *C. enteronephricus*, with intestinal enteronephry (a condition formerly restricted to the Megascolecini) which is unquestionably related to vesiculate species of *Cryptodrilus*, must be included within this genus in the Perionychini. Thus the definition of the Perionychini embraces species which would be referable to the Dichogastrini or Megascolecini on the anatomy of the excretory system but which show evident relationships with Perionychini.

Such widening of the definition of discrete groups so that they are no longer totally interdistinguishable has become accepted in modern taxonomy and is an expected extension of the concept of polythetic groups, definable by no one single character.

The genus *Cryptodrilus*, as emended above to include additional evidence from Tasmanian species, has now become a polythetic grouping as the single formerly diagnostic character, multiple nephridial bladders in a segment, no longer applies to all species. Inclusion of avesiculate species appears justified from a consideration of general anatomy. Such a variation, from vesiculate to avesiculate species is insignificant relative to the remarkable variation further discussed in the account of *C. polynephricus*, from the exonephric to the enteronephric condition in posterior segments.

Jamieson (1972a) recognized three species groups in *Cryptodrilus*. The Tasmanian species *C. avesiculatus*, *C. brunyensis*, *C. enteronephricus* and *C. polynephricus* (with

*C. albertisi*) show clear affinities with the *mediocris* group and *C. simsoni* and less certainly *C. dartnalli* probably also are placeable in it. It is not proposed, however, to redefine the group as the emended definition would be so wide as to be poorly defined from the *rusticus* and *fastigatus* groups and would have little operational value. This is not to deny that at least *fastigatus*, with its externally branched prostates, is a very unusual species. If further species with *fastigatus* prostates were found it would not be unreasonable to recognize a separate genus for such species, the name *Trinephrus* being available for it.

## Check list of species of *Cryptodrilus*

### *Tasmanian species*

*C. albertisi* (Cognetti, 1910) New combination (junior synonym of *C. polynephricus* ?)
*C. avesiculatus* sp. n.
*C. brunyensis* sp. n.
*C. dartnalli* sp. n.
*C. enteronephricus* sp. n.
*C. officeri* Spencer, 1895
*C. polynephricus* Spencer, 1895
*C. simsoni* Spencer, 1895

### *Other species*

New South Wales

*C. fastigatus* Fletcher, 1889a
*C. mediocris* Fletcher, 1889a
*C. rusticus* Fletcher, 1887a
*C. tenuis* Fletcher, 1889a

Victoria

*C. dubius* Spencer, 1892a (junior synonym of *C. fastigatus*)

## Key to Tasmanian species of *CRYPTODRILUS**

| | | |
|---|---|---|
| 1 | 3 pairs of spermathecae | ***C. officeri*** Spencer, 1895 |
| – | 2 pairs of spermathecae | 2 |
| 2 | Gizzard large, firm. Intestine commencing in XVI | 3 |
| – | Gizzard small, flaccid. Intestine commencing in XVII or XVIII | 6 |
| 3 | Caudally with median stomate nephridium on each side discharging into the intestine. Fig. 20 | ***C. enteronephricus*** sp. n. |
| – | No caudal nephridia discharging into the intestine unless anally | 4 |
| 4 | 2 nephridia present caudally in *a* line on each side: 1 astomate and discharging exonephrically, the other stomate and contributing to a longitudinal collecting duct (ureter) | 5 |
| – | Only one nephridium present caudally in *a* line on each side, astomate and exonephric. No ureter present. Fig. 18B | ***C. avesiculatus*** sp. n. |

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*Excluding *C. albertisi* (*q.v.*)

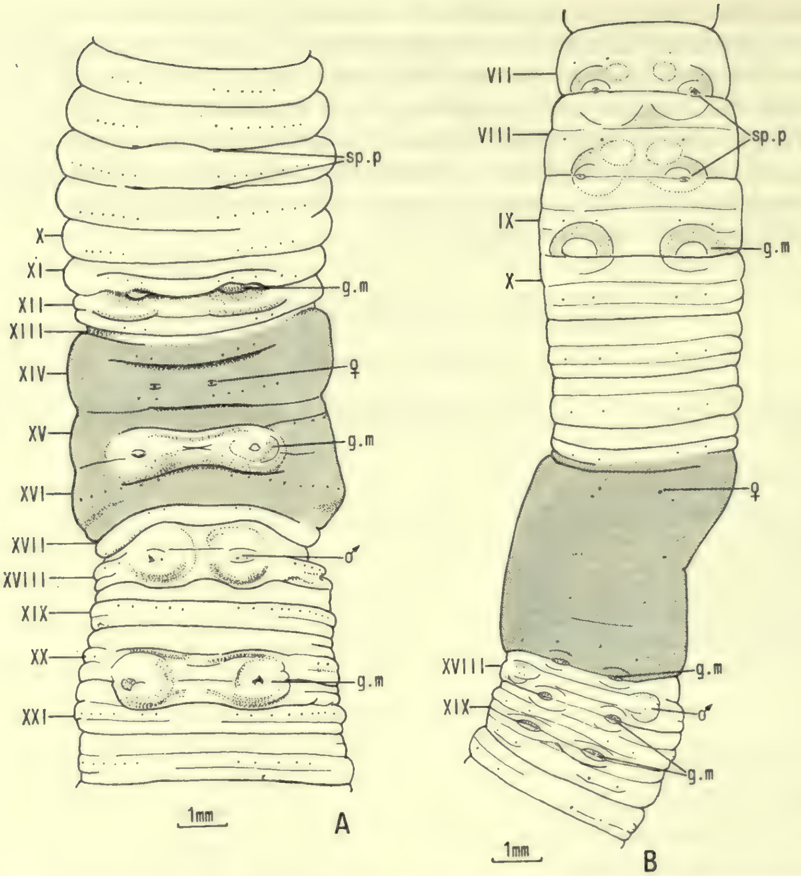

sp.p
X
XI
XII
XIII
XIV
XV
XVI
XVII
XVIII
XIX
XX
XXI
g.m
♀
g.m
♂
g.m
1mm
A
VII
VIII
sp.p
IX
g.m
X
♀
XVIII
g.m
XIX
♂
g.m
1mm
B

FIG. 18. Genital fields. A, *Hickmaniella opisthogaster*, holotype. B, *Cryptodrilus avesiculatus*, holotype.

5 No postsetal genital markings in preclitellar segments. Fig. 19A . ***C. brunyensis*** sp. n.
– Postsetal genital markings present in preclitellar segments. Fig. 21A, B, C ***C. polynephricus*** Spencer, 1895
6 Dorsal pores present. Intestine commencing in XVIII. Fig. 25A ***C. simsoni*** Spencer, 1895
– Dorsal pores absent. Intestine commencing in XVII. Fig. 19B . ***C. dartnalli*** sp. n.

## ***Cryptodrilus albertisi*** (Cognetti, 1910)

Fig. 2

*Megascolides albertisi* Cognetti, 1910 : 329–331, Fig. 3–6.

$l = 68$ mm, $w = 4$ mm, $s = 107$.

Prostomium tanylobous. Dorsal pores not observed. Ventral setae closely paired, dorsal setae distant, $aa < bc < cd$ throughout. In V–XVIII, $aa = ab + bc$ ;

$ab > bc$ ; $cd = 2bc$ ; $dd = 1{\cdot}5cd = 0{\cdot}3u$. Behind XVIII setal lines, with the exception of *a*, displaced dorsally so that, in XXX, $aa$ slightly $> ab$, but appreciably $< ab + bc$ ; $ab$ slightly $< bc$ ; $cd > 2bc$ ; $dd = aa \doteqdot 0{\cdot}14u$. Clitellum not developed. Male pores not externally visible. Accessory genital markings 3 pairs of whitish, slightly tumid papillae posteriorly in segments IX, X and XI in *b* lines. Female pores a pair anteriorly in XIV, midway between setal lines *a* and the ventral midline. Spermathecal pores 2 pairs of short transverse slits in 7/8 and 8/9, shortly lateral of *a* lines.

Last hearts in XIII. Gizzard extending from mid V to mid VI ; calciferous glands absent ; intestinal origin XVI. Nephridia 'diffuse' ; from approximately segment XXX, those of the most ventral pair, in *b* lines, are much larger than the others. Holandric ; gymnorchous ; seminal vesicles small, in IX, larger in XII, non-racemose. Prostates one pair, in XVIII–XX, the glandular part oblong with corrugated surface ; the S-shaped muscular duct penetrating the parietes in, apparently, *b*. Penial setae 800 μm long, 30 μm wide, slightly curved, ending in a point which is not very fine ; the ectal half ornamented with small scale-like projections with minutely dentate margins. Metagynous. Spermathecae 2 pairs, in VIII and IX ; ampulla transversely compressed with slightly lobulated margin with stout duct of equal length into which, a short distance from the external pore, opens a digitiform diverticulum.

TYPE-LOCALITY. Mt Wellington. Map, 14/4.

MATERIAL EXAMINED.

None available.

REMARKS. Cognetti's description is questionably adequate for identification of any material with this species. Although nephridial bladders and distribution of nephridia are not described, the distribution of accessory genital markings strongly suggests that *C. albertisi* is identical with, and therefore, a junior synonym of, *C. polynephricus* Spencer, 1895.

### ***Cryptodrilus avesiculatus*** sp. n.

Fig. 2, 18B, 31A ; Plates 2 and 3. Table 4

l = 81, 69 mm, w = 3·8, 4·0 mm, s = 116, 118.

Prostomium epilobous $\frac{2}{3}$, open. Dorsal pores absent. Setae 8 per segment, in regular longitudinal rows throughout. Nephropores not visible. Clitellum annular, $\frac{1}{2}$XIII–XVII. Male and separate penisetal pores on dome-shaped papillae in *b* of XVIII. Accessory genital markings 2 or 3 pairs of eyelike markings in 17/18 (holotype), 18/19 and 19/20 (holotype, paratype 1) in *a* lines ; postsetal paired oval markings extending over the posterior borders of their segments in VII and VIII containing the spermathecal pores (holotype) and in IX (holotype, paratype 1) ; also a faintly indicated paired postsetal patch in and ventral to *a* in VII and VIII (holotype). Female pores shortly anteromedian to setae *a* of XIV. Spermathecal pores 2 pairs, in 7/8 and 8/9, on minute papillae in *ab*.

TABLE 4

Intersetal distances in segment XII in *Cryptodrilus avesiculatus*

mm

| | *aa* | *ab* | *bc* | *cd* | *dd* | *dc* | *cb* | *ba* |
|---|---|---|---|---|---|---|---|---|
| holotype | 1·6 | 0·7 | 1·4 | 1·5 | 3·5 | 1·5 | 1·4 | 0·7 |
| paratype 3 | 1·1 | 0·6 | 1·2 | 1·4 | 2·4 | 1·4 | 1·1 | 0·6 |
| paratype 4 | 1·1 | 0·6 | 1·1 | 1·3 | 2·3 | 1·3 | 1·0 | 0·6 |
| paratype 5 | 1·4 | 0·6 | 1·1 | 1·3 | 2·1 | 1·3 | 1·0 | 0·6 |

standardized ($u = 100$)

| | *aa* | *ab* | *bc* | *cd* | *dd* | *dc* | *cb* | *ba* |
|---|---|---|---|---|---|---|---|---|
| holotype | 13·07 | 5·68 | 11·36 | 12·50 | 28·69 | 11·93 | 11·36 | 5·40 |
| paratype 3 | 11·33 | 6·37 | 12·04 | 14·51 | 24·43 | 13·81 | 11·33 | 6·02 |
| paratype 4 | 11·97 | 6·73 | 11·22 | 14·21 | 24·68 | 13·46 | 10·85 | 6·73 |
| paratype 5 | 14·96 | 6·36 | 11·59 | 13·84 | 22·44 | 13·84 | 10·47 | 6·36 |
| mean | 12·83 | 6·29 | 11·55 | 13·77 | 25·06 | 13·26 | 11·00 | 6·13 |
| interval/*ab* | 2·04 | 1·00 | 1·84 | 2·19 | 3·98 | 2·11 | 1·75 | 0·97 |

Last hearts in XII (latero-oesophageal). Supra-oesophageal present. Gizzard large, in V. Extramural calciferous glands absent but oesophagus vascularized and moniliform in IX–XIII (holotype, paratype 1) and slightly in VIII (paratype 1). Intestinal origin XVI ; typhlosole absent. Nephridia (holotype) : large (exonephric ?) tufts in III and IV ; succeeding segments with a few large avesiculate integumentary micromeronephridia on each side. Caudally 4 exonephric, avesiculate nephridia on each side discharging in front of setae *a*, *b*, *c* and *d* ; the dorsal three astomate, the medianmost nephridium, discharging in *a* with a large preseptal funnel and greatly enlarged to form a megameronephridium ; one nephridium only at the *a* locus, the megameronephridium ; no ureter. Holandric (funnels iridescent) ; gymnorchous ; seminal vesicles compact, racemose in IX and XII. Metagynous ; ovisacs absent. Prostates flattened, lobulated but linear winding through XVII–XX ; with narrow central lumen. Vasa deferentia joining the ectal end of the gland. Penial setae moderately stout, strongly curved, widened basally, the smooth delicate pointed tip upturned ; the ectal region of the shaft, with the exception of the vicinity of the tip, ornamented by a series of coarsely serrated, scarcely protuberant transverse but appreciably oblique jagged markings each of which occupies approximately one-quarter to three-quarters of the width of the seta ; length of functional seta = 1·3 mm, general width of shaft = 23 μm (holotype). Spermathecae 2 pairs ; diverticulum single, subspherical, in the axis of the duct ; ampulla a lateral appendage.

*Genital markings*. (Holotype, paratypes 1–7.) Genital markings in IX are restricted to the Port Davey specimens. In the new Harbour specimens a distinct oval genital marking is developed in front of each spermathecal pore, on VII and VIII ; there are only suggestions of these in the Port Davey specimens. All specimens, from both localities, have paired eye-like marking is 18/19 and 19/20 but only the holotype and paratype 2 have these markings in 17/18 and in only paratype 3 are they present (median to *a*) in 20/21.

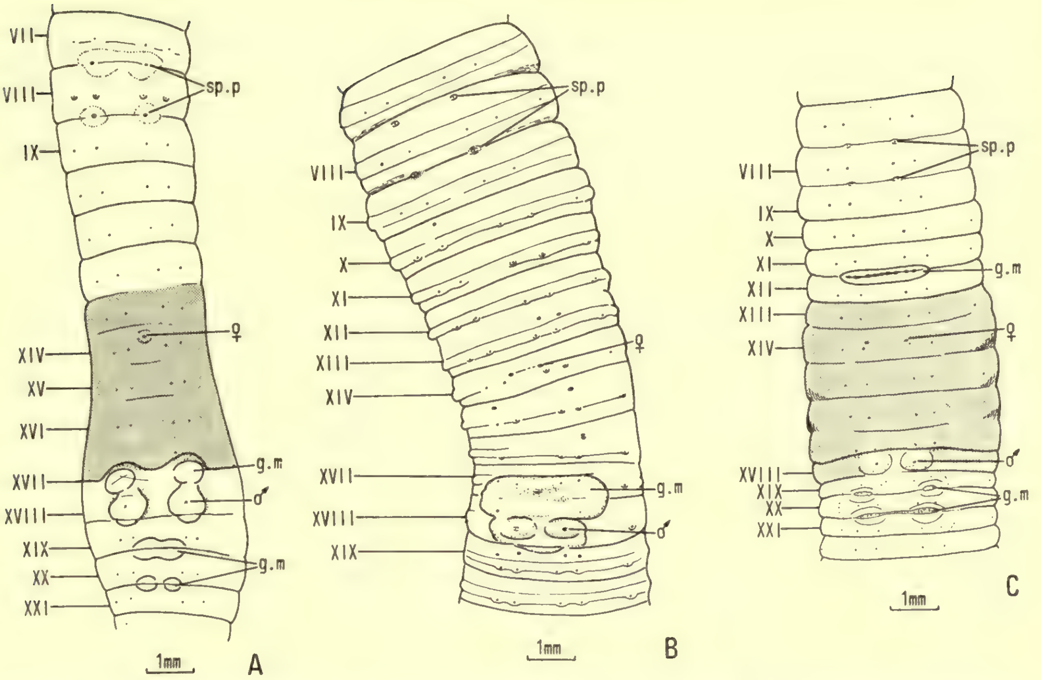

VII
VIII
IX
sp.p
♀
XIV
XV
XVI
XVII
XVIII
XIX
XX
XXI
g.m
♂
g.m
1mm
A
VIII
IX
X
XI
XII
XIII
XIV
sp.p
♀
XVII
XVIII
XIX
g.m
♂
1mm
B
VIII
IX
X
XI
XII
XIII
XIV
sp.p
g.m
♀
XVIII
XIX
XX
XXI
♂
g.m
1mm
C

FIG. 19. Genital fields. A, *Cryptodrilus brunyensis*, holotype. B, *C. dartnalli*, holotype. C, *C. simsoni*, 8/1, specimen 2.

MATERIAL EXAMINED.

Kelly's Basin, Port Davey, 145°55′E. 43°20′S. Map, 17/1, Tasmanian Biological Survey: J17, Mr C. D. King, Jan 1940 – holotype TM: K319; paratype 1 BM(NH): 1973.2.5; paratype 2 TM: K320. New Harbour, 146°70′E. 43°30′S. Map, 18/5, Mr C. D. King – paratypes 3 and 4 TM: K321–322; paratypes 5 and 6 AM: W5206–5207; paratype 7 BJ: T25.

REMARKS. *C. avesiculatus* is closely similar to *C. enteronephricus*, *C. polynephricus* or *C. brunyensis*. It differs from *C. enteronephricus* in lacking caudal enteronephry, and from *C. polynephricus* and *C. brunyensis* in lacking a ureter.

### *Cryptodrilus brunyensis* sp. n.

Fig. 2, 19A, 31B, C; Plates 4–7. Table 5

l = 48 mm, 71 mm, w = 3·0 mm, s = 83, 124.

Prostomium epilobous ½, open. Dorsal pores absent. Setae 8 per segment in regular longitudinal rows throughout. Nephropores not visible. Clitellum annular XIII–XVII. Male pores in *ab*, nearer *a*, in XVIII on subcircular papillae which extend posteriorly over 18/19 slightly into XIX and anteriorly reach the hind margins of a pair of oval genital markings in *ab* at 17/18. Two penial setae, projecting from separate follicles, median to each pore. Two additional pairs of genital markings present in 19/20 and 20/21 median to *a*, the anterior pair fused medianly (holotype); only the conjoined pair in 19/20 present in paratype 1. Female pore unpaired, midventral, between the setal arc and anterior margin of XIV. Spermathecal pores 2 pairs, in 7/8 and 8/9, in *a* lines, each surrounded by a glandular field; the fields in 7/8 (holotype) or in 7/8 and 8/9 (paratype) medianly united and suggestions of presetal markings present in *b* of IX in paratype 1.

TABLE 5

Intersetal distances in segment XII in *Cryptodrilus brunyensis*

| | | | | mm | | | | |
|---|---|---|---|---|---|---|---|---|
| | *aa* | *ab* | *bc* | *cd* | *dd* | *dc* | *cb* | *ba* |
| holotype | 0·9 | 0·5 | 1·0 | 1·3 | 1·5 | 1·3 | 1·1 | 0·5 |
| paratype 1 | 1·2 | 0·6 | 1·2 | 1·4 | 1·5 | 1·4 | 1·2 | 0·6 |
| | | | | standardized ($u$ = 100) | | | | |
| | *aa* | *ab* | *bc* | *cd* | *dd* | *dc* | *cb* | *ba* |
| holotype | 11·45 | 6·17 | 12·33 | 15·86 | 18·94 | 15·86 | 13·66 | 5·73 |
| paratype 1 | 13·03 | 6·90 | 12·64 | 15·71 | 16·48 | 15·71 | 12·64 | 6·90 |
| mean | 12·24 | 6·54 | 12·49 | 15·79 | 17·71 | 15·79 | 13·15 | 6·32 |
| interval/*ab* | 1·87 | 1·00 | 1·91 | 2·41 | 2·71 | 2·41 | 2·01 | 0·97 |

Dorsal blood vessel continuous onto the pharynx. Last hearts in XII; hearts in X–XII latero-oesophageal, each with a connective to the supra-oesophageal vessel but none to the dorsal vessel, supra-oesophageal ending at ½XIII, well developed. Gizzard firm and very large, in V. Calciferous glands absent but oesophagus internally lamellate in VIII–XIII. Intestinal origin XVI; dorsal typhlosole a low but distinctly developed lamina from XVIII but continued as a rudiment to XVI (holotype, paratype). Nephridia: loose aggregations of nephridia in II and III send several ducts anteriorly to discharge at the anterior margin of the segment; pharyngeal tufts in IV–VI, accompanied by exonephric meronephridia; in VII and VIII with a meronephridium discharging above *d*, at *d*, *cd*, *c*, *b* and several, of which some form a small tuft, at *a*; this condition persisting in succeeding segments (holotype); in the hindbody with a micromeronephridium discharging in the 4 setal lines *a*, *b*, *c* and *d* and in addition a stomate megameronephridium contributing its duct to a poorly developed longitudinal collecting duct (ureter) (holotype, paratype) which ends posteriorly at the junction of rectum and body wall and therefore appears to discharge into the anal aperture on each side; all nephridia avesiculate and only the megameronephridia with funnels (holotype). In paratype the ureter is well developed but is not certainly detectable at the caudal extremity where in *a* there is only a single (astomate ?) nephridium; those in *b*, *c* and *d* persisting.

Holandric (funnels iridescent in X and XI); gymnorchous; seminal vesicles racemose in XI and XII. Metagynous; ovisacs present. Prostates broad, flattened, linear, lobulated (tubuloracemose), in XVIII–XXI (holotype, paratype), dissected to demonstrate main central internal duct with numerous more slender lateral branches (holotype). Vasa deferentia on each side winding before joining the prostate duct at its junction with the gland. Penial seta moderately stout, strongly curved, tapering to a narrow blunt or pointed tip ; the ectal region of the shaft, with the exception of the vicinity of the tip, ornamented by numerous groups of small, irregular, conjoined teeth, the groups alternating along the seta, each containing only a few teeth but considerably notching the setal surface ; length of a functional seta = 1·9 mm ; general width of shaft = 20 μm (paratype 1). Spermathecae (not inseminated) 2 pairs, each with long convoluted duct and long clavate-digitiform diverticulum.

MATERIAL EXAMINED.

Rainforest at summit of Mt Mangana, Bruny Is., 147°15′E. 43°25′S. Map, 19/1, Mr A. J. Dartnall, 10 Apr 1971 – holotype TM : K323 ; paratype BM(NH) : 1973.2.6.

REMARKS. *C. brunyensis* is morphologically close to *C. enteronephricus*, *C. avesiculatus* and *C. polynephricus*. It differs from *C. enteronephricus* in lacking caudal enteronephry, from *C. avesiculatus* in possessing a ureter and from *C. polynephricus* in lacking preclitellar genital markings.

## ***Cryptodrilus dartnalli*** sp. n.

Fig. 2, 19B, 31D ; Plates 8–12. Table 6

l = 85+, 109 mm, w = 3·7, 3·5 mm, s = 107+, 143 (holotype, posterior amputee ; paratype 2).

Prostomium epilobous ½, closed, continued posteriorly as parallel grooves, almost giving a tanylobous condition. Dorsal pores absent. Setae 8 per segment, in regular longitudinal rows throughout. Nephropores sporadically visible presetally. Clitellum not developed (holotype) or strongly protuberant, though weak in *aa*, in XIV–XVII with some dorsal clitellar modification to ½XVIII and perhaps ½XIII (paratype 2). Male pores small slits on XVIII in *a* on ovoid papillae which extend laterally as far as *b* and well median of *a*. Glandular tumescence extending from setal arc of XVII to shortly behind 18/19, reaching mid *bc* at 17/18, and including the male porophores (holotype), similar in paratype 1 in which a pair of faint eye-like genital markings is present on the tumescence in 17/18 in *b* ; indistinctly developed in paratype 2 and other New Harbour specimens and obscured in these by insinking of the male field. Female pores a pair very shortly anteromedian of setae *a* on XIV. Spermathecal pores 2 pairs of small slits on small but distinct papillae, in 7/8 and 8/9, in *a*.

TABLE 6

Intersetal distances in segment XII in *Cryptodrilus dartnalli*

mm

| | *aa* | *ab* | *bc* | *cd* | *dd* | *dc* | *cb* | *ba* |
|---|---|---|---|---|---|---|---|---|
| holotype | 1·1 | 0·6 | 1·3 | 1·2 | 4·5 | 1·2 | 1·3 | 0·6 |
| paratype 1 | 1·1 | 0·7 | 1·5 | 1·4 | 4·8 | 1·5 | 1·6 | 0·7 |
| paratype 2 | 1·2 | 0·8 | 1·6 | 1·4 | 5·8 | 1·3 | 1·6 | 0·7 |

Table 6 (*cont.*)

| | standardized (*u* = 100) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | ***aa*** | ***ab*** | ***bc*** | ***cd*** | ***dd*** | ***dc*** | ***cb*** | ***ba*** |
| holotype | 9·15 | 4·88 | 10·98 | 10·37 | 38·41 | 10·37 | 10·98 | 4·88 |
| paratype 1 | 8·59 | 5·37 | 11·28 | 10·20 | 35·98 | 11·28 | 11·81 | 5·37 |
| paratype 2 | 8·16 | 5·28 | 11·04 | 9·60 | 39·60 | 9·12 | 11·04 | 4·80 |
| mean | 8·63 | 5·18 | 11·10 | 10·06 | 38·00 | 10·26 | 11·28 | 5·02 |
| interval/*ab* | 1·67 | 1·00 | 2·14 | 1·94 | 7·34 | 1·98 | 2·18 | 0·97 |

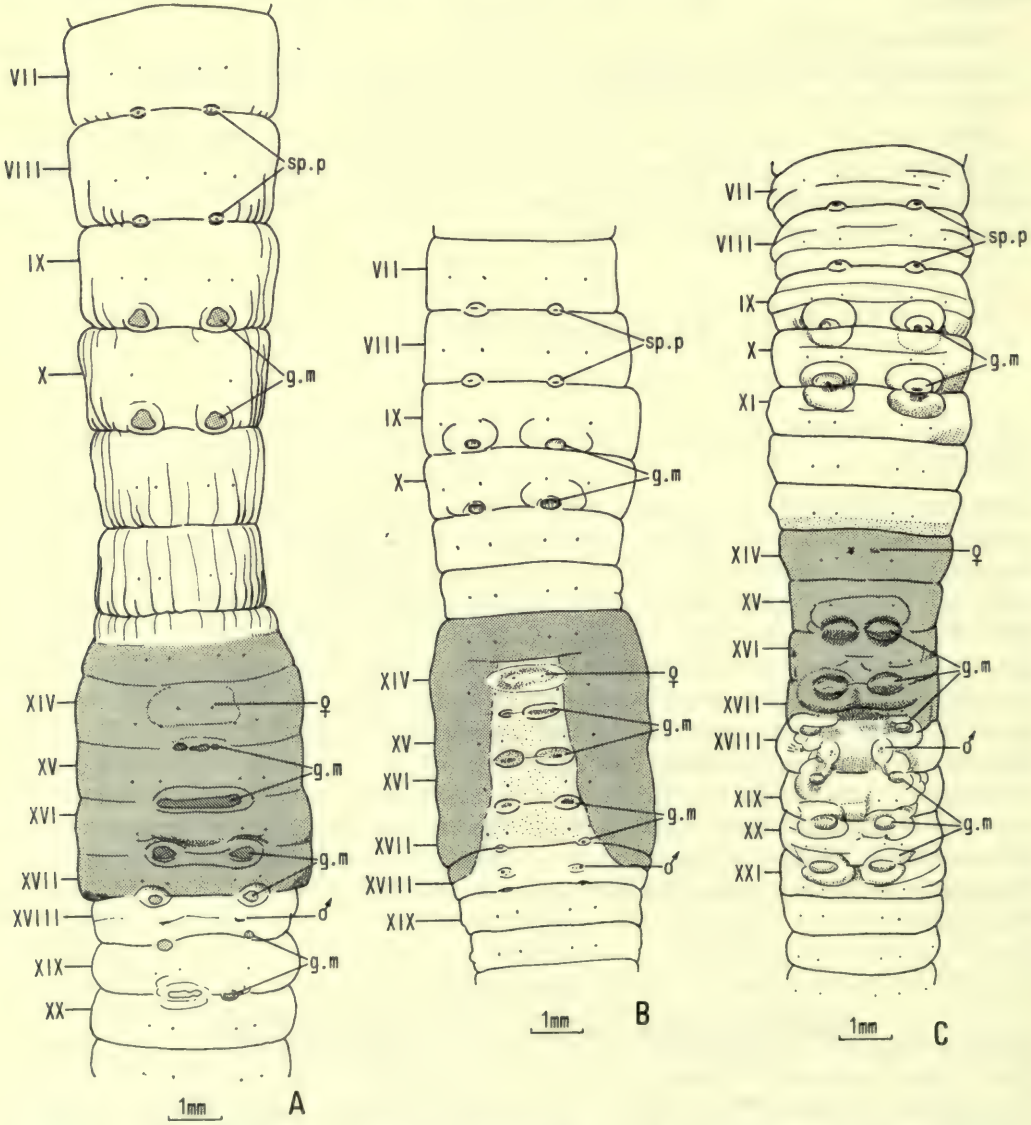

VII
VIII
sp.p
IX
X
g.m
XIV
♀
XV
g.m
XVI
XVII
g.m
XVIII
♂
XIX
g.m
XX
1mm
A
VII
VIII
sp.p
IX
X
g.m
XIV
♀
XV
g.m
XVI
g.m
XVII
♂
XVIII
XIX
1mm
B
VII
VIII
sp.p
IX
X
g.m
XI
XIV
♀
XV
XVI
g.m
XVII
XVIII
♂
XIX
XX
g.m
XXI
1mm
C

FIG. 20. Genital fields. *Cryptodrilus enteronephricus*: A, holotype; B, paratype 18; C, paratype 3.

Last hearts in XIII (latero-oesophageal; connectives to dorsal vessel not demonstrable). Supra-oesophageal in VII–XIII, well developed. Gizzard vestigial, in V, but musculature thicker than elsewhere. Extramural calciferous glands absent; oesophagus with circumferential vascular striae and internal papilliform rugae, in VII–XIII (holotype), XIV (paratype); chloragogenous and narrower in XIV (holotype), XV (paratype 2)–XVI, though with internal rugae in XIV in holotype; intestinal origin XVII; typhlosole absent. Nephridia: in the forebody, astomate, avesiculate, exonephric meronephridia commencing in II, few in number, all (?) associated with setal lines *a*, *b*, *c* and *d*; tufts absent. Caudally in the four setal lines, or in *a*–*c* and above *d*, the median-most nephridium with a preseptal funnel. Holandric (funnels iridescent in X and XI); gymnorchous; seminal vesicles spheroidal, in IX and XII. Metagynous; ovisacs absent (holotype), but small sacs (ovisacs ?) in XIV in paratype 2. Prostates flattened tubular, tortuous, in XVIII and XIX; two vasa deferentia joining the junction of each gland with its sinuous muscular duct (holotype) or joining the ectal region of the gland (paratype 2). Penial setae moderately stout, gently curved, tapering to a narrow point; the ectal region of the shaft, with the exception of the vicinity of the tip, ornamented by oblique laterally sometimes interrupted circlets of irregular coarse teeth which are directed anteriorly but may be considerably elevated at their apices from the setal surface; the circlets approximately 7 μm apart (holotype, paratype 8); length of functional seta 0·8–1·0 mm; general width of shaft 22, 17 μm (holotype, paratype 8). Spermathecae 2 pairs. Diverticulum single, digitiform uniloculate; shorter relative to the ampulla in paratype 2 compared with the holotype.

MATERIAL EXAMINED.

Melaleuca Inlet, Port Davey, 145°55′E. 43°20′S. Map, 17/1, Mr A. J. Dartnall, Dec 1967 – holotype TM: K220, paratype 1 TM: K324. New Harbour, 146°10′E. 43°30′S. Map, 18/5, Mr C. D. King, 27 Jan 1938 – paratypes 2 and 3 BM(NH): 1973.2.7–8; paratypes 4–6 AM: W5208–5210; paratypes 7–8 BJ: T26–27.

REMARKS. The genital field of *C. dartnalli* is diagnostic but the species shows close affinities with *C. simsoni*. It differs from the latter, among other respects, in lacking dorsal pores and in origin of the intestine one segment further forward, in XVII.

### ***Cryptodrilus enteronephricus*** sp. n.

Fig. 2, 20, 31E–G; Plates 13–19. Table 7

l = 124, 110 mm, w = 4·6, 4·0 mm, s = 162, 168.

Prostomium epilobous ⅔ with narrow open dorsal tongue. Dorsal pores absent. Setae 8 per segment in regular longitudinal rows throughout. Nephropores not, or only sporadically, visible. Clitellum annular, ½XIII–XVIII (paratype 1) or XVII, with weak extension to ½XVIII (holotype). Male pores small transverse slits, not on porophores, in *ab* of XVIII, nearer *a* than *b* (holotype) or (paratype 1) nearer *b* than *a*, with two penisetal pores median to each pore, the three pores of a side on a small indefinite papilla. Paired accessory genital markings at the posterior borders of IX and X in *ab*, intersegmental in 16/17 in *a* and 17/18 and 18/19 in *ab* (holotype, paratype 1), and intersegmental in 19/20 in and median to *ab* (holotype); median markings occupying *aa* in 14/15 and 15/16 (holotype, paratype 1). Female pores anteromedian to setae *a* of XIV, at approximately ⅓*aa*. Spermathecal pores 2 pairs, in 7/8 and 8/9, on small distinctly protuberant papillae in *ab*, shortly lateral of *a*.

TABLE 7

Intersetal distances in segment XII in *Cryptodrilus enteronephricus*

| | mm | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | *aa* | *ab* | *bc* | *cd* | *dd* | *dc* | *cb* | *ba* |
| holotype | 1·0 | 0·5 | 1·3 | 1·3 | 2·0 | 1·3 | 1·3 | 0·5 |
| paratype 1 | 1·3 | 0·6 | 1·5 | 1·8 | 2·7 | 1·7 | 1·5 | 0·6 |
| paratype 3 | 1·2 | 0·5 | 1·3 | 1·3 | 1·8 | 1·3 | 1·3 | 0·5 |
| paratype 4 | 1·2 | 0·6 | 1·9 | 1·6 | 2·6 | 1·6 | 2·0 | 0·6 |
| paratype 6 | 1·3 | 0·6 | 1·7 | 1·8 | 2·5 | 1·8 | 1·7 | 0·6 |
| paratype 14 | 1·0 | 0·6 | 1·3 | 1·6 | 2·0 | 1·5 | 1·4 | 0·6 |
| paratype 15 | 1·7 | 0·8 | 1·5 | 1·9 | 2·6 | 1·9 | 1·5 | 1·0 |
| | standardized ($u$ = 100) | | | | | | | |
| | *aa* | *ab* | *bc* | *cd* | *dd* | *dc* | *cb* | *ba* |
| holotype | 10·89 | 5·06 | 14·40 | 14·01 | 21·79 | 14·01 | 14·79 | 5·06 |
| paratype 1 | 11·03 | 5·07 | 13·11 | 15·50 | 22·65 | 14·30 | 13·11 | 5·07 |
| paratype 3 | 12·55 | 4·94 | 14·45 | 14·45 | 19·77 | 14·45 | 14·45 | 4·94 |
| paratype 4 | 10·09 | 4·90 | 15·56 | 13·26 | 21·61 | 13·26 | 16·43 | 4·90 |
| paratype 6 | 10·88 | 5·00 | 13·82 | 15·29 | 20·88 | 15·29 | 13·82 | 5·00 |
| paratype 14 | 10·15 | 5·60 | 12·60 | 15·75 | 19·95 | 15·40 | 13·65 | 5·60 |
| paratype 15 | 12·69 | 6·48 | 11·61 | 14·85 | 19·98 | 14·58 | 11·34 | 7·29 |
| mean | 11·18 | 5·29 | 13·65 | 14·73 | 20·95 | 14·47 | 13·94 | 5·41 |
| interval/*ab* | 2·11 | 1·00 | 2·58 | 2·78 | 3·96 | 2·74 | 2·64 | 1·02 |

Last hearts in XIII (latero-oesophageal with supraoesophageal but no dorsal connectives in X–XIII). Commissurals in IX anteriorly, slender and dorsoventral, lacking supra-oesophageal connectives. Supra-oesophageal vessel in VIII–XIV, well developed.

Gizzard large and firm, with anterior rim, in V. Calciferous glands absent. Oesophagus vascularized in VIII–XIV. Intestinal origin XVI; a deep laminar dorsal typhlosole present, rapidly increasing in depth from XVIII, continued as a very low ridge or thickening into XVI; muscular thickening and caeca absent. Nephridia: large tufts in II–V send sheaves of forwardly directed ducts to the buccal cavity and pharynx, those in II discharging at the junction of buccal cavity and body wall, those in III entering the buccal cavity and those in IV and V joining the pharynx behind the brain. Succeeding segments with several astomate, avesiculate, exonephric parietal micromeronephridia on each side. Caudally with 4 exonephric, astomate, micromeronephridia on each side discharging in *a*, *b*, *c* and *d* lines and in addition a very large stomate megameronephridium which has a large preseptal funnel near the ventral nerve cord and loops far laterally (to approximately *c* line) before turning medianly to send a duct to the ventrolateral surface of the intestine, i.e. enteronephric. All 5 nephridia on each side persisting to the caudal extremity. No ureter present.

Holandric (funnels iridescent in X and XI); gymnorchous; seminal vesicles racemose, in IX, X and XII. Metagynous; small ovisacs in XIV. Prostates linear, depressed, winding in XVIII–XXI; much lobulated but with a narrow axial lumen (tubuloracemose) but that on the right side in the holotype a broad flattened lobe in XVIII–XX and not resolvable into a linear form; vasa deferentia joining gland near its junction with the sinuous muscular duct. Penial setae moderately stout, gently curved, tapering ectally to a simple, moderately sharp (paratype 1) or (artefact ?) truncated tip (paratype 14); the ectal region of the shaft, with the exception of the vicinity of the tip ornamented by about 20 irregular serrated circlets approximately 6 $\mu$m apart; the serrations forming jagged lines with, here and there, individual narrow pointed teeth recognizable. The circlets complete or interrupted along the lateral aspect of the seta, if interrupted the two halves tending to alternate along the seta. Length 1·05, 0·81 mm; general width of shaft = 28 $\mu$, 22 (paratypes 1, 14). Spermathecae 2 pairs, with ovoid ampulla and approximately equally long duct which is joined at midlength by an ovoid unstalked diverticulum.

*Genital markings.* The following conclusions are drawn from examination of the holotype and eight fully clitellate paratypes: paired genital markings are always present posteriorly in X but may be absent (paratypes 4, 5) in IX; the greatest extent of genital markings occurs in P10 in which, in addition to the markings in IX and X, there are median markings in 13/14 and 14/15 and paired markings in each of intersegmental furrows 15/16–20/21; markings are present in all specimens in each of intersegments 15/16–18/19. Those in 15/16 are usually median as are those in 14/15 if present; those in 13/14 (seen in only two specimens) are median or paired; all other markings are paired though there may be some tendency to unite medianly. Paired markings in IX and X are virtually in line with the spermathecal pores, in *ab* usually nearer *a*.

Distribution of accessory genital markings
in *Cryptodrilus enteronephricus*

| | H | P1 | P2 | P3 | P4 | P5 | P6 | P7 | P10 | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| IX | p | p | p | p | | | p | p | p | 7 |
| X | p | p | p | p | p | p | p | p | p | 9 |
| 13/14 | | | | | p | | | | m | 2 |
| 14/15 | m | m | | | p | | m | m | m | 6 |
| 15/16 | m | m | m | p | pm | pm | m | m | p | 9 |
| 16/17 | pm | p | p | p | pm | p | p | pm | p | 9 |
| 17/18 | p | p | p | p | p | p | p | p | p | 9 |
| 18/19 | p | p | p | p | p | p | p | p | p | 9 |
| 19/20 | p | | p | p | p | p | | | p | 6 |
| 20/21 | | | p | p | p | p | | | p | 5 |

m = median; p = paired; pm = paired tending to fuse medianly. H = holotype; P = paratype.

*Other variations.* Seven specimens, including the holotype, were examined internally. Constant features included: location of gizzard in V; intestinal origin in XVI ; large typhlosole ; enteronephric megameronephridia caudally and absence of bladders ; seminal vesicles in IX, X and XII ; presence of penial setae and 2 pairs of spermathecae. A major variation was location of last hearts in XII in paratypes 3, 4 and 5, in contrast with location in XIII in the holotype and paratypes 1, 6 and 10. Such variation is highly exceptional intraspecifically but there appear to be no grounds for regarding the individuals with hearts in XII as specifically distinct. Ovisacs were seen only in paratypes 1 and 5.

MATERIAL EXAMINED.

Dee Bridge, Lyell Highway, 146°35′E. 42°15′S. Map, 13/7, Dr J. L. Hickman, 24 May 1954 – holotype TM : K325. Tarraleah, Lyell Highway, 146°25′E. 42°20′S. Map, 13/4, Dr J. L. Hickman, 22 May 1954 – paratypes 4 and 5 AM : W5211–5212 ; paratypes 18 and 19 BJ : T34–35. Tarraleah, over pipeline, Dr J. L. Hickman, 27 May 1954 – paratypes 11–15 BJ : T28–32. Marlborough Highway (near Bronte), 146°30′E. 42°10′S. Map, 13/6, Dr J. L. Hickman, 26 May 1954 – paratype 1 BM(NH) : 1973.2.9 ; paratype 2 BJ : T33 ; paratypes 6–10 TM : K326–330. Lyell Highway, 5 miles from Bronte towards Hobart, 146°35′E. 42°15′S. Map, 13/7, Dr J. L. Hickman, 24 May 1954 – paratype 3 BM(NH) : 1973.2.10.

REMARKS. *C. enteronephricus* appears to be related to *C. polynephricus*, and especially to the subspecies *urethrae*, but differs notably from that species (*q.v.*) in having enteronephric intestinal nephridia. The development of enteronephry represents a major departure from perionychin organization and the attainment of a condition previously known only in the distinct tribe Megascolecini which, in *sens. strict.*, is otherwise represented in Tasmania only by *Oreoscolex*.

## ***Cryptodrilus* ? *officeri* Spencer, 1895**

Fig. 2

*Cryptodrilus officeri* Spencer, 1895 : 44–45, Pl. III, fig. 28–30.
*Trinephrus officeri* ; Michaelsen, 1900 : 186–187.
*Notoscolex officeri* ; Jamieson, 1971c : 79.
*Cryptodrilus officeri* ; Jamieson, 1972b : 166.

l = 44 mm, w = 6 mm, s ?

Prostomium epilobous ¾. First dorsal pore 4/5. Setae 8 per segment, irregular caudally. Clitellum annular, XIV–XVII. Male pores on papillae on XVIII, in *b*. Accessory genital markings paired elliptical patches in 15/16 and 16/17 in *b*, and in 19/20 in *ab*. Female pores presetal and close together in XIV. Spermathecal pores 3 pairs, in 6/7–8/9, shortly above *b*.

Last hearts in XII, no continuous supra-oesophageal. Gizzard well marked, segment ? (no distinct septa in front of 7/8) ; true calciferous glands absent but vascular swellings in XIII–XV ; intestinal origin XVII. Nephridia ; 3 tufts on each side. Holandric ; seminal vesicles racemose in IX and XII. Metagynous. Spermathecae 3 pairs, in VII, VIII and IX ; diverticulum a group of finger-like processes, the ampulla long and irregular in outline.

TYPE-LOCALITY. King River Valley. Map, 12/1.

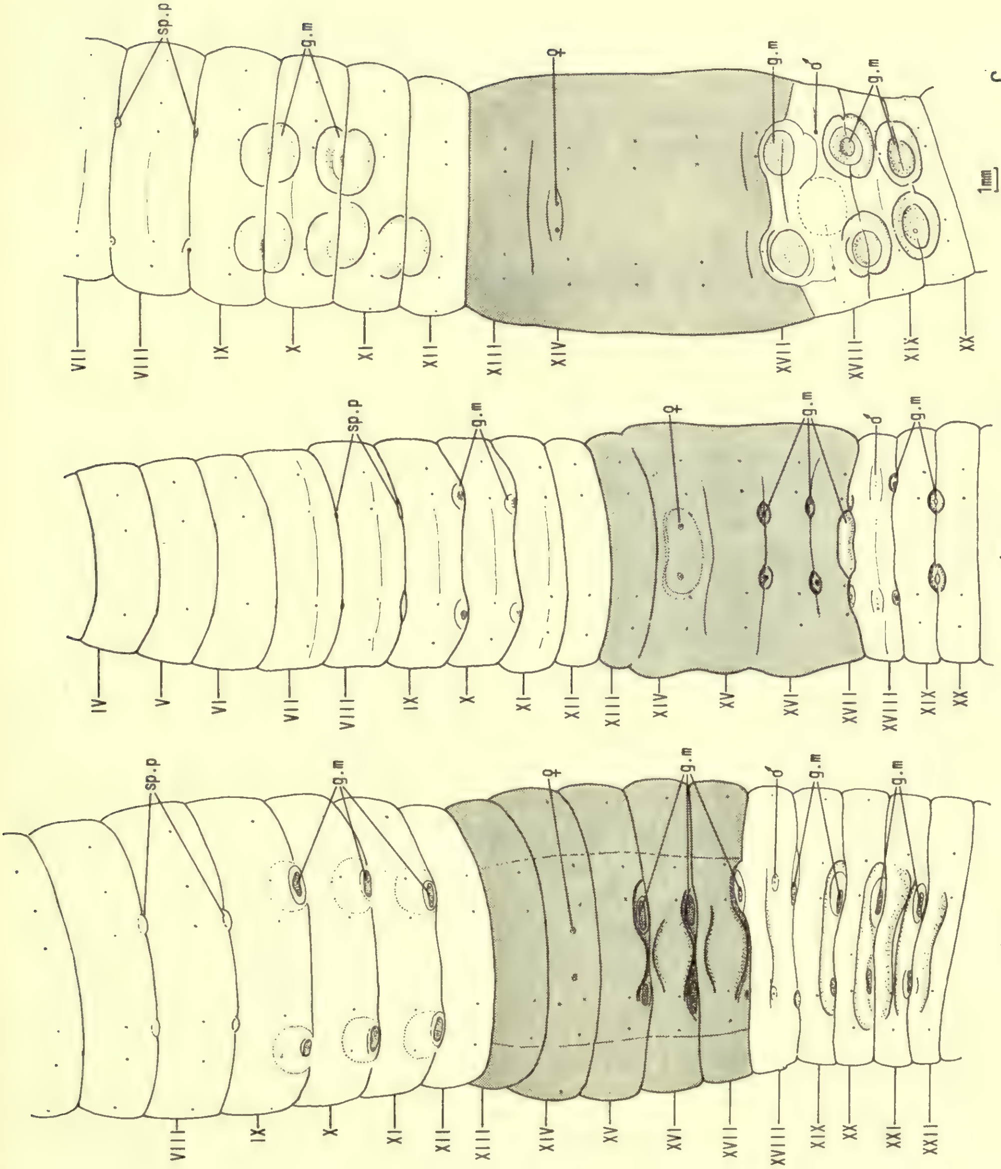

A
B
C
sp.p
g.m
♀
♂
1mm
IV
V
VI
VII
VIII
IX
X
XI
XII
XIII
XIV
XV
XVI
XVII
XVIII
XIX
XX
XXI
XXII

FIG. 21. Genital fields. A, *Cryptodrilus polynephricus polynephricus*, specimen 1. B, *C. p. p.* ad *urethrae*, specimen 44. C, *C. p. urethrae*, holotype.

MATERIAL EXAMINED.

None available.

REMARKS. Spencer's statement that the nephridia are like those of *C. fastigatus* and *C. dubius* necessitates placing *officeri* in *Cryptodrilus* but inclusion in this genus is questionable. The multiloculate spermathecal diverticulum raises the possibility that it is an *Oreoscolex*, the 3 pairs of spermathecae and the configuration of the genital field being reminiscent of *O. sexthecatus*. The latter species is distinguished, so far as the inadequate description of *C. officeri* indicates, by the more ventral position of the spermathecal pores (in *b* lines). New material of *C. officeri* is required if its status is to be settled.

## ***Cryptodrilus polynephricus*** Spencer, 1895

*Cryptodrilus polynephricus* Spencer, 1895 : 35–36 Pl. 1, fig. 4, 5, 6.

l = 98–330 mm, w (midclitellar) = 4·5–12 mm, s = 127–175.

Prostomium epilobous ½, ⅔ to tanylobous, sometimes canaliculate. Dorsal pores absent. Setae 8 per segment, in regular longitudinal rows throughout ; *a* and *b* absent on XVIII. Nephropores minute, only sporadically if at all visible. Clitellum annular, XIII–XVII. Male pores on XVIII in *ab*, not usually on papillae ; 2 separate penisetal follicles usually visible median to each male pore. Accessory genital markings ; an anterior series of 3 pairs of elliptical markings posteriorly in IX, X and XI, or at the posterior intersegment of each of these, in *ab*, or median of *a*, or some or all of these markings absent, or additional markings present at the posterior margins of VII, VIII and XII. A posterior series of paired or median transverse markings present in or immediately anterior to some of intersegments 12/13–21/22, more commonly in 17/18–19/20. Female pores in XIV, paired anteromedian of *a*, or unpaired midventral and presetal. Spermathecal pores 2 pairs, in 7/8 and 8/9, in or slightly lateral of *a*.

Last hearts in XIII (exceptionally, in some specimens of *urethrae*, in XII) those in X–XIII latero-oesophageal, with connectives from the supra-oesophageal vessel only. Gizzard large, strongly muscular, with anterior rim, in V. Extramural calciferous glands absent. Intestinal origin XVI ; typhlosole absent, rudimentary or deep laminar ; muscular thickening and caeca absent. Nephridia : several pairs of meronephric tufts discharging into the foregut ; exonephric micromeronephridia present in most segments on each side in the four setal rows, usually with additional intervening nephridia, caudally with the medianmost nephridium enlarged as a megameronephridium, with preseptal funnel, the duct of which contributes to a longitudinal excretory duct (ureter) which apparently discharges into the ureter ; nephridial bladders present or absent, if present number in a segment ranging from 4 to 10 per side. Testes and iridescent sperm funnels in X and XI ; gymnorchous ; seminal vesicles in IX and XII, or XI and XII or rarely IX, XI and XII. Prostates tubuloracemose, extending through 2 or more segments. Penial setae long and stout, when functional 0·7–4 mm long, with the general width of the shaft 23–45 μm.

Metagynous ; ovisacs present or absent. Spermathecae 2 pairs, in VIII and IX, diverticulum single, digitiform, uniloculate with or without a basal swelling.

Type-locality. Mt Wellington. Map, 14/4. Parattah. Map, 14/1.

Distribution. See subspecies.

Remarks. Two subspecies are here recognized and described below. Where a subspecific character does not vary from the specific description it is not repeated in the subspecific account.

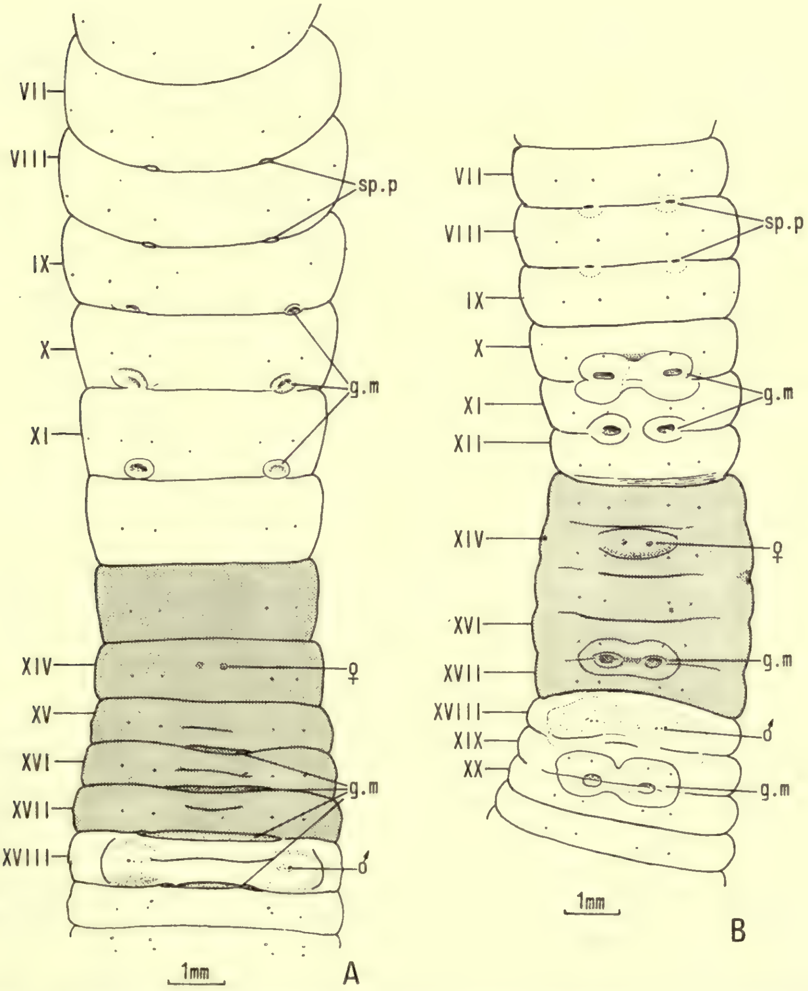

VII
VIII
IX
X
XI
XIV
XV
XVI
XVII
XVIII
sp.p
g.m
♀
g.m
♂
1mm
A
VII
VIII
IX
X
XI
XII
XIV
XVI
XVII
XVIII
XIX
XX
sp.p
g.m
♀
g.m
♂
g.m
1mm
B

Fig. 22. Genital fields. *Cryptodrilus polynephricus polynephricus* : A, specimen 7 ; B, specimen 24.

## ***Cryptodrilus polynephricus polynephricus*** Spencer, 1895

Fig. 2, 21A, 22, 24A, 31H ; Plates 20–31. Table 8

*Cryptodrilus polynephricus* Spencer, 1895 : 35–36, Pl. 1, fig. 4, 5, 6.
*Trinephrus polynephricus* ; Michaelsen, 1900 : 185–186.
*Cryptodrilus polynephricus* ; Jamieson, 1972b : 169–172, Fig. 6D, 7E, F, G.

l = 98–200 mm (44 specimens), the extreme specimens with midclitellar widths of 4·5 and 8 mm, and segmental counts of 127 and 158, respectively.

Male pores not usually on papillae, sometimes on oval papillae which extend beyond *a* and *b* and occupy the posterior three-fourths of the segment. Accessory genital markings : characteristically with 3 pairs of anterior genital markings (raised or depressed glandular ellipses) posteriorly in IX, X and XI, in *ab*, in IX in or shortly median to *b* ; in X slightly median to *b* or at approximately mid *bc* ; in XI at mid *ab* or nearer but not in *a*, i.e. *lateral* of the line of the spermathecal pores and convergent posteriorly.

Table 8

Intersetal distances in segment XII in 14 specimens* of
*Cryptodrilus polynephricus polynephricus*

mm

| | *aa* | *ab* | *bc* | *cd* | *dd* | *dc* | *cb* | *ba* |
|---|---|---|---|---|---|---|---|---|
| maximum | 2·3 | 0·9 | 2·0 | 4·1 | 4·4 | 4·0 | 1·9 | 0·9 |
| minimum | 1·1 | 0·6 | 1·3 | 1·5 | 2·1 | 1·4 | 1·1 | 0·3 |
| mean | 1·8 | 0·7 | 1·6 | 2·8 | 3·2 | 2·7 | 1·6 | 0·7 |
| standard deviation | 0·3 | 0·1 | 0·2 | 0·9 | 0·7 | 0·8 | 0·2 | 0·1 |

standardized ($u$ = 100)

| | *aa* | *ab* | *bc* | *cd* | *dd* | *dc* | *cb* | *ba* |
|---|---|---|---|---|---|---|---|---|
| maximum | 13·45 | 6·90 | 14·94 | 20·86 | 24·41 | 20·50 | 13·64 | 0·36 |
| minimum | 10·63 | 3·54 | 9·24 | 13·03 | 18·16 | 13·22 | 8·43 | 3·54 |
| mean | 12·19 | 5·10 | 11·15 | 17·89 | 20·79 | 17·27 | 10·69 | 4·93 |
| standard deviation | 1·20 | 0·99 | 1·63 | 2·43 | 1·69 | 2·35 | 1·73 | 0·88 |
| interval/*ab* | 2·39 | 1·00 | 2·19 | 3·51 | 4·08 | 3·39 | 2·10 | 0·97 |

* Specimens 1, 4, 5, 7, 10, 12, 14, 18, 24, 26, 32, 34, 37 and 38.

Some individuals (14/4, 27 Oct 1955 ; 13 Nov 1954) lacking markings in IX and with those in X and XI in or median of *a*. Posterior genital markings in or immediately anterior to intersegmental furrows : median at 14/15, occasionally ; paired or median at 15/16, commonly ; paired or median at 16/17, 17/18 and 18/19, almost invariably ; paired but usually medianly conjoined in 19/20, usually, in 20/21, commonly, and in 21/22 rarely ; the paired markings centred from *ab* to median of *a*. Female pores are an inconspicuous pair in XIV, anteromedian of *a*. Spermathecal pores on small papillae.

Internal anatomy (paralectotype 1 ; gross anatomy confirmed from all localities and details from 14/4, specimen 12) : supra-oesophageal vessel in $\frac{1}{2}$VIII–$\frac{1}{2}$XIII, moderately developed. Oesophagus somewhat dilated in VIII ; in IX–XIII moderately and uniformly dilated and slightly moniliform ; in XIV and XV more slender. Intestinal typhlosole absent though in specimen 12 a low diffuse dorsal ridge is perceptible from XXIV posteriorly.

Nephridia : vesiculate stomate and astomate nephridia and several pairs of meronephric buccal tufts. The ovoid-subspherical bladders each receive a single duct from a simple or completely coiled nephridium. The arrangement of the bladders is as follows : at the posterior end of the body there are 5 (presetal) bladders on each side, one in each of the four setal rows and a supernumerary bladder in *cd*, giving 10 bladders per segment ; the nephridia supplying these posterior bladders are small and compact but there is in addition an enlarged nephridium (megameronephridium), with a preseptal funnel, the duct of which contributes to a longitudinal excretory duct (ureter), passes through many caudal segments and appears to discharge at junction of rectum and body wall. In the forebody a bladder persists in each of the four setal lines of a side but, in addition 1–3 supernumerary bladders are present in *cd* and 1 or 2, usually 2, between *d* line and the middorsal line ; very occasionally there is a single supernumerary bladder in *bc*. The number of bladders on *each* side in the forebody thus varies from 4 to 10. No bladders are detectable in segments I and II (paralectotype 1) but one is present in *d* in specimen 12, and the *a* bladder appears to be absent in III and is not observable in paralectotype 1, though present in specimen 12 in the anterior spermathecal segment, VIII. Where two bladders are present above *d*, one is anterior in the segment and the other is equatorial and less lateral. Sporadically in paralectotype, but not in specimen 12, there are two bladders in *c*, one anterior and one shortly presetal. Numbers of bladders counted on one side in paralectotype 1 are : I, 0 ; II, 0 ; III, 4 ; IV, 6 ; V, 9 ; VI, 9 ; VII, 8 ; VIII, 7 ; IX, 9 ; X, 10 ; XI, 10 ; XII, 10 ; XIII, 9 ; post-prostatic, 8 ; caudal, 5 ; these numbers agreeing well though not always exactly with those in specimen 12. Large paired tufted nephridia, each consisting of numerous spiral loops, lie in segments II–IX ; each tuft in III–IX contributes to a composite duct which is continuous, on each side of the nerve cord, from segment IX to the lower lip of the mouth (paralectotype 1) or the buccal cavity (specimen 12). Each of the pair of tufts in II sends a separate composite duct to the lower lip, lateral of the other longitudinal duct and sends a few very slender ducts laterally to the body wall presetally in *c* although no bladder is detectable.

Simple large saccular seminal vesicles in IX and XII. Prostates irregular, lobulated to racemose, linear structures, extending through XVIII–XXI (XVIII–XIX in paralectotype 3) ; each with a sinuous narrow muscular duct which is joined entally near its junction with the gland, by the vas deferens. In transverse section (paralectotype 1) each gland is seen to have a narrow central lumen around which are many distinct groups of glandular cells, each group with the appearance of a liver lobule. The cells of the lobule radiate from a central axis which in some cases can be seen to form a definite lumen although this is not lined by a recognizable epithelium. The epithelium of the central lumen of the gland is sporadically interrupted to receive the lumina or axial cores of the lobuli. Width of the gland : width of the central lumen = 1·61 : 0·18 mm = 9 : 1. Penial setae stout, curved, tapering ectally to a simple blunt tip ; the ectal tapered region strongly convex 'dorsally', less convex, to concave, 'ventrally'. The ectal region typically (paralectotype 3) ornamented with approximately 16 circlets spaced at regular intervals averaging 10 μm, each circlet serrated by very numerous simple minute contiguous spines; the spines anteriorly directed, adpressed to the surface of the seta, only slightly notching the seta in profile. Specimens from other localities are similar in general form and may have similar ornamentation, or the circlets may be interrupted in such a way that the different portions are not always in the same transverse line, and in some specimens (e.g. 7/2, specimen 1) there is no regular transverse arrangement of spines but merely scattered short transverse groups. Sometimes (13/4, specimen 5) there are short spine-like ridges adherent longitudinally to the setal surface immediately ectal to the spines (and also a tendency to longitudinal furrowing of the seta); the presence of ridges in this specimen approaches the condition characteristic of *C. polynephricus polynephricus* ad *urethrae* (q.v.); lengths of well developed setae 0·73–1·5 mm, general width of shaft 23–37 μm (paralectotype 3; specimens 1, 5, 10, 14, 18, 24, 34, 42). Metagynous; ovisacs not developed (paralectotype 1) or present (specimen 12 and other, but not all, specimens). Spermathecal diverticulum (inseminated) digitiform.

TYPE-LOCALITY. Mt Wellington; Hobart. Map, 14/4. Parattah. Map, 14/1.

MATERIAL EXAMINED.

Mt Wellington, 147°15′E. 42°55′S. Map, 14/4, NMV : G1436, 3 paralectotypes.* Fern Glade, Emu R., Burnie, under logs, 145°55′E. 41°05′S. Map, 7/2, Dr J. L. Hickman, 17 May 1954 – specimens 1–4 BM(NH) : 1973.2.11–14. Tarraleah, over pipeline, 146°25′E. 42°20′S. Map 13/4, Dr J. L. Hickman, 27 May 1954 – specimens 5–6 BM(NH) : 1973.2.15–16. Collinsvale, near Hobart, myrtle forest, 147°15′E. 42°50′S. Map, 14/3, Dr J. L. Hickman, 8–9 Nov 1955 – specimens 7–11 BJ : T38–42. Mt Wellington, 147°15′E. 42°55′S. Map, 14/4, Dr J. L. Hickman, 27 Oct 1955 – specimens 12 and 13 BJ : T39–40; under stones on top of mountain, Dr J. L. Hickman, 13 Nov 1954 – specimen 14 BJ : T41; specimen 15 AM : W5213; specimens 16 and 17 BM(NH) : 1973.2.17–18. Shoobridge Bend track, altitude approximately 580 m, in loam and clay in eucalypt – fern woodland, Dr B. G. M. Jamieson and Mr E. A. Bradbury, 19 Aug 1971 – specimens 18–23 BJ : T42–47. Hobart, Waterworks Road, under stones, 147°20′E. 42°50′S. Map, 14/5, Dr J. L. Hickman, 17 Aug 1954 – specimen 24 BM(NH) : 1973.2.19; specimen 25 BJ : T48. Lenah Valley, near Newton Falls, under stones, Dr J. L. Hickman, 24 Jun 1957 – specimen 26 AM : W5214; specimens 27–33 AM : 5305–5311; Lenah Valley, New Town Creek, Dr J. L. Hickman, 15 Sep 1953 – specimens 34–36 TM : K331–333; 31 Aug 1953 – specimen 37 TM : K334. 'Tasmania', Dr J. L. Hickman, specimens 38–41 TM : K335–338.

REMARKS. In the above account the occurrence of a pair of longitudinal excretory ducts and associated stomate megameronephridia is demonstrated for the first time.

*C. polynephricus polynephricus* is distinguishable from *C. p. urethrae* and from the closely related *C. enteronephricus* in location of the anterior genital markings, or at least those in IX, significantly lateral of the spermathecal pores. The similarity, nevertheless, of the genital fields and general anatomy of *C. polynephricus* and *C. enteronephricus*, and the intermediate position of *C. p. urethrae* (q.v.) indicate speciation from a common origin within the genus.

* The specimen designated the lectotype by Jensz and Smith (1969), G41, is here shown to be a specimen of *Perionychella* (*Vesiculodrilus*) *mortoni*. This specimen is clearly not a syntype as it did not contribute to the type-description of *C. polynephricus*. Smith has agreed that its designation as the lectotype was invalid according to Article 74(a)(i) of the International Code of Zoological Nomenclature.

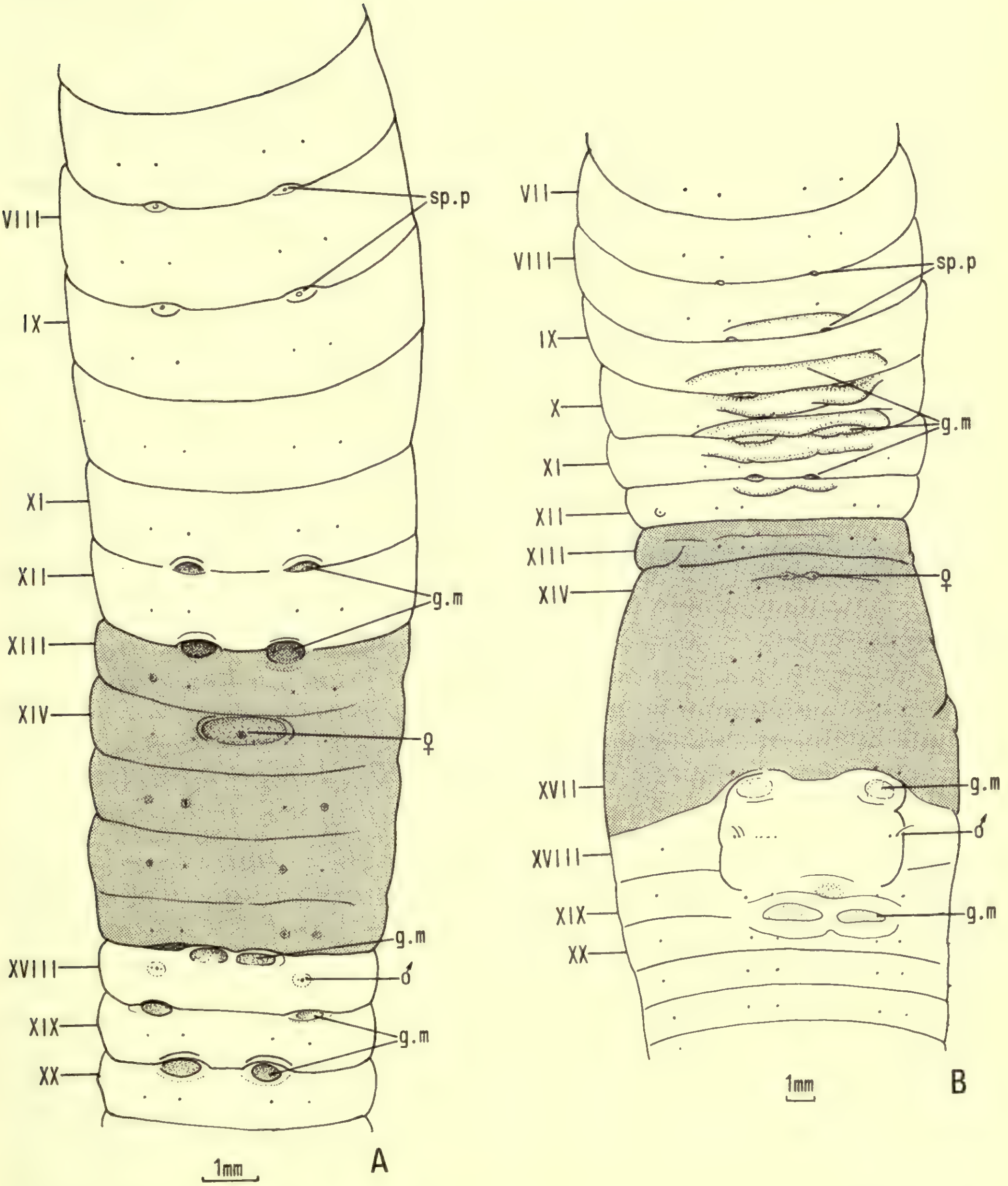

sp.p
VIII
IX
XI
XII
g.m
XIII
XIV
♀
g.m
XVIII
♂
XIX
g.m
XX
1mm
A
VII
VIII
sp.p
IX
X
g.m
XI
XII
XIII
XIV
♀
XVII
g.m
♂
XVIII
XIX
g.m
XX
1mm
B

FIG. 23. Genital fields. *Cryptodrilus polynephricus urethrae* : A, paratype 8 ; B, paratype 20.

Specimens 14–17, from the summit of Mt Wellington, and specimens 24 and 25, from Hobart, display a distinct genital field, lacking genital markings in IX, and having those in X and XI further median than is usual. They are also characterized by a longitudinal reduplication of the nephridial bladders in *c* lines but the latter condition occurs sporadically, in some segments, in the paralectotypes of which, though they are incompletely mature, one has rudiments of a normal field, with genital markings in IX and X well lateral of the spermathecal pores. As the nephridial condition of the atypical specimens is echoed in the types, and in view of the great variation in the genital fields reported for another species of *Cryptodrilus* (*C. fastigatus* v. Jamieson, 1972b) erection of a separate taxon for specimens 14–17, 24 and 25 does not seem warranted.

### ***Cryptodrilus polynephricus urethrae*** subsp. n.

Fig. 2, 21C, 23, 24C, 31J–M ; Plates 44–59. Table 9

l = 330, 160 mm ; w = 12, 6 mm ; s = 175, 156.

Prostomium epilobous $\frac{1}{2}$, $\frac{2}{3}$ ; dorsal tongue moderately narrow, closed and (in holotype) weakly canaliculate. Paired elliptical accessory genital markings with centres in *a* and with wide, whitish glandular borders, in intersegments 9/10 and 10/11 (holotype, paratype 1) and 11/12 (paratype 1) or unilateral, on the right, in holotype. Similar markings centred in *a* in 17/18 ; in *ab*, nearer *a*, in 18/19 and median to *a* in 19/20. Female pore in XIV, paired anteromedian of *a* in holotype ; unpaired, midventral, in paratype 1. Spermathecal pores very slightly lateral of *a*.

TABLE 9

Intersetal distances in segment XII in 13 specimens* of *Cryptodrilus polynephricus urethrae*

| | mm | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | *aa* | *ab* | *bc* | *cd* | *dd* | *dc* | *cb* | *ba* |
| holotype | 4·0 | 1·1 | 2·4 | 2·3 | 14·0 | 2·6 | 3·0 | 1·1 |
| maximum | 4·0 | 1·1 | 2·9 | 3·3 | 14·0 | 3·1 | 3·0 | 1·1 |
| minimum | 1·6 | 0·6 | 1·6 | 1·9 | 2·7 | 1·9 | 1·6 | 0·6 |
| mean | 2·5 | 0·9 | 2·1 | 2·3 | 6·7 | 2·3 | 2·1 | 0·9 |
| standard deviation | 0·8 | 0·2 | 0·4 | 0·4 | 3·4 | 0·3 | 0·4 | 0·2 |
| | standardized ($u$ = 100) | | | | | | | |
| | *aa* | *ab* | *bc* | *cd* | *dd* | *dc* | *cb* | *ba* |
| holotype | 13·02 | 3·72 | 7·91 | 7·44 | 45·58 | 8·37 | 9·77 | 4·19 |
| maximum | 16·14 | 5·83 | 14·29 | 15·92 | 45·58 | 15·92 | 14·29 | 5·83 |
| minimum | 9·30 | 3·45 | 7·91 | 7·44 | 20·11 | 8·37 | 9·09 | 3·45 |
| mean | 12·61 | 4·71 | 10·76 | 12·20 | 31·91 | 12·19 | 10·88 | 4·75 |
| standard deviation | 1·75 | 0·72 | 1·81 | 2·74 | 7·66 | 2·43 | 1·53 | 0·69 |
| interval/*ab* | 2·68 | 1·00 | 2·28 | 2·59 | 6·77 | 2·59 | 2·31 | 1·01 |

* H, paratypes, 1, 7, 8, 9, 10, 12, 13, 16, 18, 20, 21 and 22.

Supra-oesophageal vessel recognizable in $\frac{1}{2}$VIII, IX–XIII, XIV well developed. Oesophagus vascularized and dilated segmentally in VIII–XIII, XIV ; intestinal typhlosole absent or a rudimentary, very low ridge present from approximately XXIV (paratype 1 and holotype respectively). Nephridia: 5 pairs of large tufts, each with multiple ducts, in II–VI; the ducts of those of II discharging at the junction of mouth and body wall; those of III–VI sending composite ducts to a simple, though still composite, common longitudinal duct which passes forwards to the anterior end of the pharynx (i.e. enteronephric); sparse exonephric micromeronephridia present on the body wall lateral to each tuft. Nephridia in VII forming smaller tufts which discharge exonephrically in this segment (and holotype, in VI ?) and appear to send some ducts to the common duct of the anterior tufts; a tendency to ventral tufting continues but decreases to the anterior intestinal region where there are approximately 10 (paratype 1) to 15 (holotype) exonephric micromeronephridia on each side; the nephridia discharging presetally in *a*, *b*, *bc*, *c*, *cd* and above *d*. The median nephridium of the first intestinal segment (XVI) is the first to have a preseptal funnel (lying in XV) (demonstrated in paratype 1). This arrangement of nephridia persists posteriorly but the stomate nephridium now enlarges to become a megameronephridium, the duct of which discharges in *a* line together with one or two astomate micromeronephridia. Caudally there is an astomate micromeronephridium in each of setal lines *a*, *b*, *c* and *d* and 4 above *d* on each side (holotype, there being few if any above *d*, but additional intersetal nephridia in paratype 1); the megameronephridium contributes its duct to a slender longitudinal excretory duct (ureter) of which there is one on each side of the ventral nerve cord; the posterior end of this ureter was traced into the extreme caudal segments but its termination was not elucidated. Nephridial bladders totally absent.

Racemose seminal vesicles in XI and XII (holotype, paratype 1) with a unilateral rudiment in IX in holotype. Prostates depressed tubuloracemose, in XVIII–XIX (holotype)–XX (paratype 1), irregular in width and lobulated, with very narrow central lumen. Penial setae moderately stout, ectally strongly curved, the tip, which may or may not be reflexed dorsally or bent ventrally, strongly flattened and almost parallel sided, only slightly tapering ectally, and sometimes ventrally somewhat inrolled; the end almost straight or convex and simple or denticulate; ornamentation ental to the depressed apical region (holotype) consisting of numerous transverse rows, spaced at approximately 6 $\mu$m intervals, each row minutely serrate, the teeth of the serrations very numerous, closely continguous, in a single series, minute but attenuated in the axis of the seta, short ridges like a fringe present ectal to each tooth row; the setal surface also with numerous longitudinal furrows. In other specimens the tooth rows may be broken up into short transverse or oblique series of several to many teeth and these groups may lie in the same transverse or oblique line as adjacent groups or may be scattered apparently randomly. length = 2·1–3·9 mm, general width of shaft = 39–45 $\mu$m (holotype; paratypes 1, 6, 20).

Spermathecal diverticulum simple, uniloculate but with a basal swelling.

### VARIATION.

*Genital markings*. The genital field in this subspecies is distinguished from that of *C. p. polynephricus* by location of the post-spermathecal, preclitellar accessory genital markings in or median to the longitudinal lines of the spermathecal pores;

the latter pores are usually in or very slightly lateral of *a* lines. In paratypes 18 and 19 the genital markings are further lateral in *ab*, but are not significantly lateral of the spermathecal pores as these are similarly displaced. It can be seen in the following table that the genital fields in the holotype and paratype 1 are representative of the most common conditions in the remaining paratypes. Paratypes 2, 6 and 22 are shown to have atypical fields but at present there appears to be no justification for giving them separate taxonomic status.

Variation in the genital markings of 26 specimens of
*Cryptodrilus polynephricus urethrae*

| Genital markings | Specimen | Total number of specimens |
|---|---|---|
| Small elliptical paired in *ab* to median of *a* at hind margin of VII | P6, 22 | 2 |
| VIII | P2, 22 | 2 |
| IX | P2 | 1 |
| X | P2 | 1 |
| Paired intersegmental in line with or median to the spermathecal pores in 9/10 | H P1, 3, 4, 5, 10, 11, 16, 17, 18, 19, 20, 21, 23, 25, 26 | 16 |
| 10/11 | H P1–5, 10, 11, 12, 13, 14, 16, 17, 18, 19, 20–26 | 21 |
| 11/12 | H(R) P1–5, 8, 12–14, 18–21, 23–26 | 18 |
| 12/13 | P4, 5, 8, 12 | 4 |
| 16/17 | P9 | 1 |
| 17/18 | H P1–5, 10–14, 16–19, 21–26 | 21 |
| 18/19 | H P1–6, 8, 10–12, 14, 16–19, 21–26 | 22 |
| 19/20 | H P1–6, 8, 10–13, 16–19, 21 | 17 |
| 20/21 | P8 | 1 |
| 21/22 | P8 | 1 |

H = holotype; P = paratype.

*Other variation.* Anatomical variation in this subspecies in some systems exceeds what would normally be expected within a species. Thus though a typhlosole is absent or rudimentary in the holotype and paratype, respectively, there is a definite laminar typhlosole in paratypes 2, 10, 11 and 20 and appreciable typhlosoles are present in a considerable proportion of the remaining type-specimens. In specimens from the same sample (e.g. 13/3, paratypes 10–12) there may be variation from a deep, to a moderate, to a very rudimentary typhlosole. Other morphological variation does not appear to correlate with this typhlosole variation and all specimens are distinguished from the typhlosolate *C. enteronephricus* in lacking segmentally enteronephric nephridia and in having a ureter. Variation in the distribution of seminal vesicles also occurs from IX and XII, to IX, XI and XII, to XI and XII and, most remarkably, the female pore is paired or (paratypes 1, 3, 4, 8, 12, 26) unpaired, median.

Variation in setal ratios is considerable (Table 9) and one of the more extreme variants (paratype 9) has the last hearts in XII.

REMARKS. The location of the preclitellar genital markings approximately in line with or median to the spermathecal pores, the absence of nephridial bladders and the widened ends of the penial setae distinguish this subspecies from the nominate subspecies.

MATERIAL EXAMINED.

Arne Road, E. side of Styx River bridge, approx. 1000 ft into rainforest, 146°35′E. 42°50′S. Map, 13/8, Mr D. Frankombe, 24 Sep 1958 – holotype TM : K341 ; paratype 2 TM : K342. Arne Valley, 10 miles from Greeveston, 146°50′E. 43°10′S. Map, 18/3, Dr J. L. Hickman, 11 Nov 1955 – paratype 1 BM(NH) : 1973.2.24 ; paratypes 3–5 TM : K343–345 ; paratypes 22–25 TM : K346–349. Florentine Valley, surface soil under litter in *E. regnans* forest, under stones, 146°25′E. 42°35′S. Map, 13/3, Mr M. Gilbert, 7 Mar 1956 – paratype 6 BM(NH) : 1973.2.25 : Florentine, Mr J. M. Gilbert, 21 Jul 1955 – paratype 7 TM : K350 ; Florentine, rainforest soil, Mr J. M. Gilbert, 4 Aug 1955 – paratypes 8 and 9 AM : W5313–5314 ; Florentine Valley, under pieces of wood and bark, Mr J. M. Gilbert, 14–19 ? Aug 1955 – paratypes 10–12 AM : W5315–5317. Tarraleah, 146°25′ E. 42°20′S. Map, 13/4, Professor V. V. Hickman, Dec 1953 – Jan 1954 – paratypes 13 and 14 BJ : T52–53. Dee Bridge, Lyell Highway, 146°35′E. 42°15′S. Map, 13/7, Dr J. L. Hickman, 24 May 1954 – paratype 15 BJ : T54. Maydena, 146°40′E. 42°45′S. Map, 13/9, Dr J. L. Hickman, 15 Oct 1960 – paratypes 16 and 17 BM(NH) : 1973.2.26–27. Russel River, Mr C. D. King, 16 Feb 1939 – paratypes 18 and 19 BJ : T55–56. Kallista, near Junee, 146°35′E. 42°45′S. Map, 13/11, Mrs Rodway, Tasmanian Biological Survey : De13, 19 Apr 1938 – paratype 20 BJ : T57. Snowy Mts, 4000 ft, 146°40′E. 43°00′S. Map, 18/2, Tasmanian Biological Survey : J8, Mr C. D. King, 19 Jan 1939 – paratype 21 TM : K351.

REMARKS. The separate subspecies, *C. polynephricus urethrae* (and possibly it should be a species) is recognized for specimens which have anterior genital markings in or median to the spermathecal lines and which lack bladders while possessing ureters. It appears to be linked to the nominate subspecies by intermediate forms which are described below.

Whether *polynephricus* and *urethrae* are to be retained as subspecies or should be regarded as sibling species cannot be unequivocally decided at present as knowledge of them is limited to their morphology and inadequate geographical evidence. The map (Fig. 2) shows that they are largely allopatric. Their morphological similarity, which exceeds that between most species, and the occurrence of morphological intermediates where their distributions overlap, are taken for the time being to indicate that they are subspecies.

### *Cryptodrilus polynephricus polynephricus* ad *urethrae*

Fig. 2, 21B, 24B, 31I ; Plates 32–43. Table 10

Some specimens (42–45, 47, 49), referable to *C. polynephricus polynephricus* from the appearance of the preclitellar genital field, differ from paralectotypes and other specimens described above in having the nephridial bladders limited to the hindbody where they are accompanied, as usual, by a ureter. These specimens are here included in the nominate subspecies but are distinguished as *Cryptodrilus polynephricus*

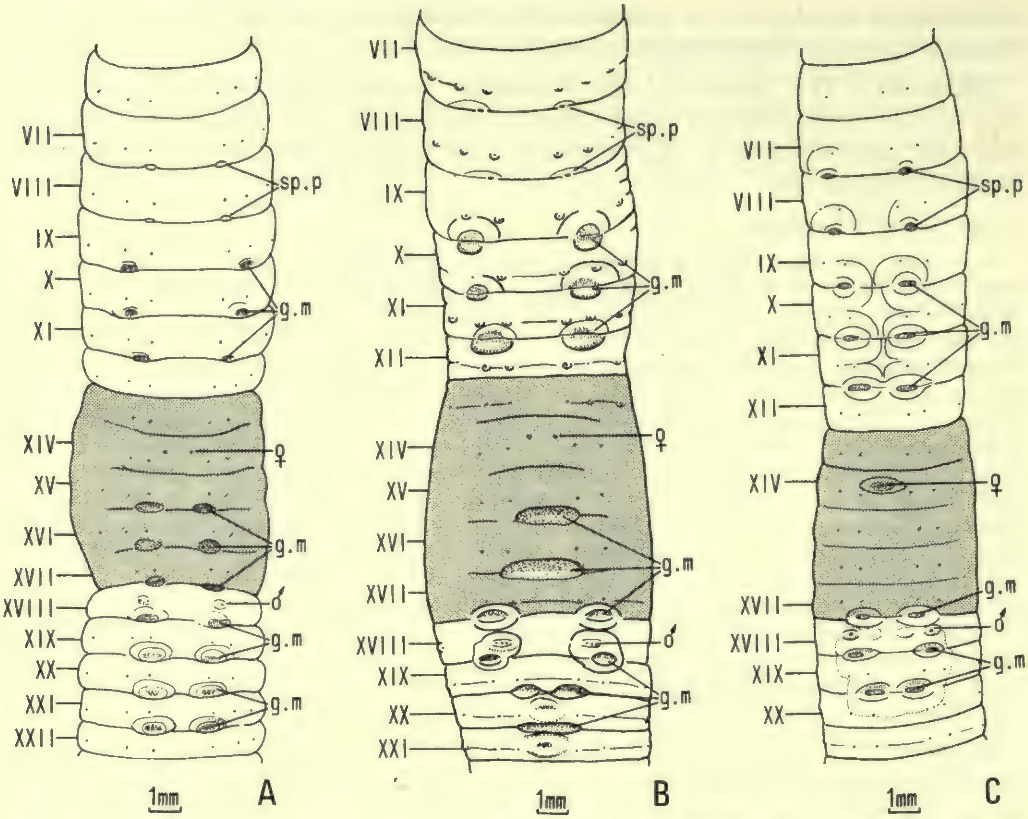

VII
VIII
IX
X
XI
XIV
XV
XVI
XVII
XVIII
XIX
XX
XXI
XXII
sp.p
g.m
♀
g.m
♂
g.m
g.m
1mm
A
VII
VIII
IX
X
XI
XII
XIV
XV
XVI
XVII
XVIII
XIX
XX
XXI
sp.p
g.m
♀
g.m
♂
g.m
1mm
B
VII
VIII
IX
X
XI
XII
XIV
XVII
XVIII
XIX
XX
sp.p
g.m
♀
g.m
♂
g.m
1mm
C

FIG. 24. Genital fields. A, *Cryptodrilus polynephricus polynephricus*, specimen 12. B, *C. p. p.* ad *urethrae*, specimen 49. C, *C. p. urethrae*, paratype 1.

*polynephricus* ad *urethrae*. With these are included two specimens (46 and 48) in which genital fields are undeveloped but which have the same nephridial condition. This '*polynephricus* ad *urethrae*' morph, in addition to general morphological resemblance to *C. p. polynephricus*, further resembles the latter in having seminal vesicles in IX and XII and simple-pointed penial setae although in specimen 44 this shows signs of the flattening characteristics of the penial setae of *C. p. urethrae*. (The latter specimen is exceptional in having last hearts in XII.) The ornamentation of some penial setae also seems to be intermediate between that in the two subspecies. As shown in the map (Fig. 2), the distribution of *polynephricus* ad *urethrae* is intermediate between, though partly overlapping, the distributions of the two subspecies, on present evidence. Details of the penial setae follow : setae stout, curved, tapering ectally to a simple blunt or flattened chisel-like tip ; where simple tipped, the ectal tapered region strongly convex dorsally, less convex, to concave, ventrally. The ectal region ornamented with numerous transverse or oblique circlets, at intervals of approximately 10 $\mu$m, each circlet serrated by very numerous spines which in some specimens (e.g. 13/3, specimen 42) are two deep and are immediately preceded ectally by short spine-like ridges adherent longitudinally to the setal surface. Spines anteriorly directed, adpressed to the setal surface, only slightly notching the seta in profile. The circlets in some (e.g. 13/3, specimen 44) broken up and a regular transverse arrangement scarcely apparent. In 14/4, specimen 48, the setal surface bears numerous longitudinal furrows. In specimen 44 the spines are simple, and ridges and significant furrowing are lacking but the tip differs from the typical *polynephricus* condition in being flattened ; l = 0·55–1·75 mm, general width of shaft = 19–30 μm (specimens 42, 44, 48, 49).

TABLE 10

Intersetal distances in segment XII in *Cryptodrilus polynephricus* ad *urethrae*

mm

| | *aa* | *ab* | *bc* | *cd* | *dd* | *dc* | *cb* | *ba* |
|---|---|---|---|---|---|---|---|---|
| specimen 42 | 1·3 | 0·6 | 1·1 | 1·6 | 2·6 | 1·8 | 1·1 | 0·6 |
| specimen 44 | 1·0 | 0·4 | 1·0 | 1·0 | 1·6 | 1·0 | 1·0 | 0·4 |
| specimen 45 | 1·0 | 0·4 | 0·9 | 1·0 | 1·3 | 1·0 | 1·0 | 0·4 |
| specimen 47 | 1·5 | 0·6 | 1·3 | 1·8 | 2·3 | 1·7 | 1·3 | 0·6 |
| specimen 48 | 1·3 | 0·7 | 1·1 | 1·5 | 2·5 | 1·5 | 1·1 | 0·7 |
| specimen 49 | 2·0 | 0·8 | 1·5 | 2·3 | 3·4 | 2·3 | 1·5 | 0·8 |

standardized (*u* = 100)

| | *aa* | *ab* | *bc* | *cd* | *dd* | *dc* | *cb* | *ba* |
|---|---|---|---|---|---|---|---|---|
| specimen 42 | 12·00 | 5·33 | 10·67 | 15·33 | 24·00 | 16·67 | 10·67 | 5·33 |
| specimen 44 | 14·15 | 5·37 | 13·17 | 13·17 | 21·95 | 13·66 | 13·17 | 5·37 |
| specimen 45 | 14·21 | 5·58 | 13·20 | 14·72 | 18·78 | 14·72 | 13·20 | 5·58 |
| specimen 47 | 13·25 | 5·36 | 11·99 | 16·09 | 20·82 | 15·14 | 11·99 | 5·36 |
| specimen 48 | 12·46 | 6·40 | 10·44 | 14·81 | 24·24 | 14·81 | 10·44 | 6·40 |
| specimen 49 | 13·73 | 5·39 | 10·29 | 15·69 | 23·53 | 15·69 | 10·29 | 5·39 |
| mean | 13·30 | 5·57 | 11·63 | 14·97 | 22·22 | 15·12 | 11·63 | 5·57 |
| interval/*ab* | 2·39 | 1·00 | 2·09 | 2·69 | 3·99 | 2·71 | 2·09 | 1·00 |

### MATERIAL EXAMINED.

Florentine Valley, surface soil under litter in *E. regnans* forest, under stones, 146°25′E. 42°35′S. Map, 13/3, Mr M. Gilbert, 7 Mar 1956 – specimens 42 and 43 TM : K339–340 ; specimens 44 and 45 BJ : T49–50. Russell River, 146°40′E. 42°45′S. Map, 13/9, Mr C. D. King, 16 Feb 1939 – specimen 46 BM(NH) : 1973.2.20. Mt Wellington, 147°15′E. 42°55′S. Map, 14/4, Dr J. L. Hickman, 13 Jan 1954 – specimen 47 AM : W5312 ; Betts Vale at creek, in moss, under logs and stones, Dr J. L. Hickman, 4 Mar 1954 – specimen 48 BJ : T51. Eagle Hawk Neck, in kelp on rocks, 147°55′E. 43°00′S. Map, 19/2, Dr J. L. Hickman, Apr 1956 – specimen 49 BJ : T51A.

## ***Cryptodrilus simsoni*** Spencer, 1895

Fig. 2, 25A, 31N, O ; Table 11

l = 61 mm, w = 4, 4·1 mm, s = 95+ (posterior amputee), 125 (lectotype, specimen 2).

Prostomium canaliculate, epilobous ⅔, closed. First dorsal pore 3/4. Setae 8 per segment in longitudinal rows, *d* irregular posteriorly. Nephropores not visible

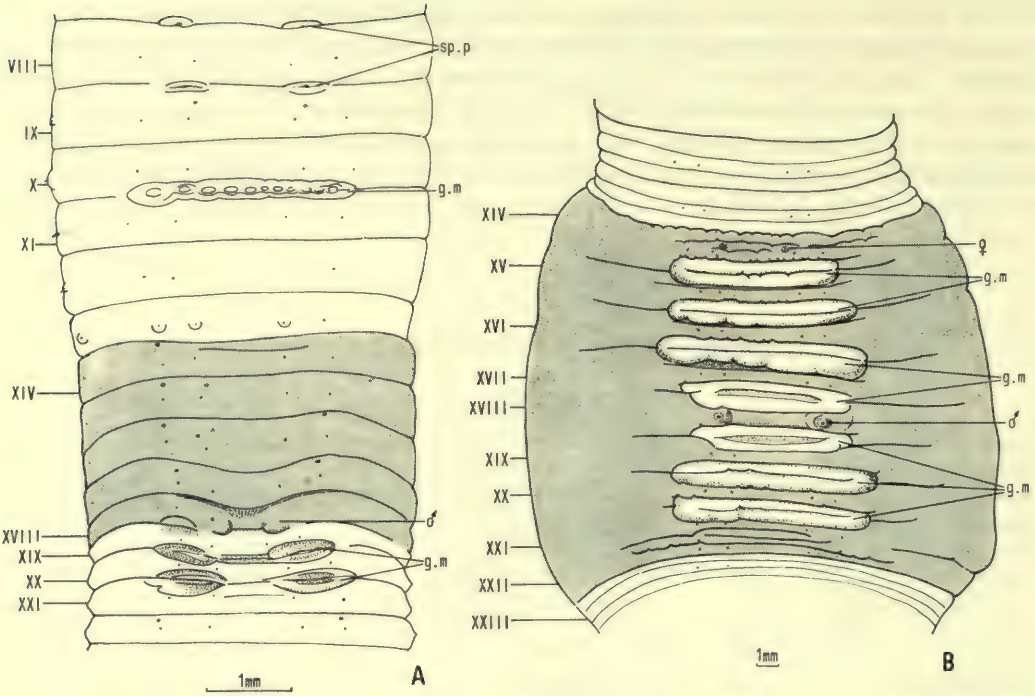


FIG. 25. Genital fields. A, *Cryptodrilus simsoni*, lectotype. B, *Pinguidrilus tasmanicus*, lectotype.

(specimen 2) or sporadically visible throughout (lectotype) and especially distinct on and shortly behind the clitellum where in each segment there are 6 presetal pores on each side; 1 median to *a*, 1 in each of *a*, *b*, *c* and *d* and 1 near the dorsal midline (lectotype). In some Fern Dene specimens there are as many as 3 presetal pores in the vicinity of each of setae *a* and *b* on the clitellum. Clitellum annular, XIII–XVIII, weak in XIII and XVIII but well developed between. Male pores on dome-shaped papillae with diameter equalling *ab* and central pore in *a*, on XVIII. Paired eye-like genital markings with centre in *b* at 19/20 and in *ab* at 20/21; a median transverse genital marking occupying *bb* in 11/12 (specimen 2) or 10/11 (lectotype) bearing a row of approximately 10 small circular markings corresponding with the intersegmental furrow. Female pores a pair of small slits just median and slightly anterior to *a* on XIV. Spermathecal pores 2 pairs, in 7/8 and 8/9, on small papillae in *a* (specimen 2) or slightly lateral of *a* (lectotype).

Last hearts in XIII (latero-oesophageal); connectives to dorsal and supra-oesophageal vessels present. Supra-oesophageal in IX–XIII (specimen 2); indistinct in lectotype. Gizzard small, easily compressible, in V. Extramural calciferous glands absent. Oesophagus with circumferential vascular striae and internally papilliform rugae in X–XVI (specimen 2), the rugae becoming definite lamellae in XIV–XV and less distinct in XVI in lectotype. Intestinal origin XVIII; typhlosole absent.

### TABLE 11

Intersetal distances in segment XII in *Cryptodrilus simsoni*

mm

| | *aa* | *ab* | *bc* | *cd* | *dd* | *dc* | *cb* | *ba* |
|---|---|---|---|---|---|---|---|---|
| lectotype | 1·4 | 0·4 | 1·3 | 1·4 | 4·8 | 1·3 | 1·3 | 0·4 |
| specimen 1 | 1·1 | 0·6 | 1·1 | 1·3 | 4·7 | 1·4 | 1·1 | 0·5 |
| specimen 2 | 1·0 | 0·5 | 1·2 | 1·1 | 4·3 | 1·1 | 1·2 | 0·5 |
| specimen 3 | 1·1 | 0·4 | 1·2 | 1·3 | 4·4 | 1·3 | 1·2 | 0·4 |
| specimen 4 | 1·1 | 0·5 | 1·0 | 1·3 | 4·3 | 1·3 | 1·1 | 0·5 |
| specimen 5 | 1·0 | 0·5 | 1·2 | 1·4 | 3·8 | 1·4 | 1·2 | 0·5 |

standardized ($u$ = 100)

| | *aa* | *ab* | *bc* | *cd* | *dd* | *dc* | *cb* | *ba* |
|---|---|---|---|---|---|---|---|---|
| lectotype | 11·48 | 3·36 | 10·08 | 11·20 | 38·64 | 10·64 | 10·08 | 3·08 |
| specimen 1 | 9·73 | 5·01 | 9·37 | 11·21 | 39·23 | 11·50 | 9·44 | 4·13 |
| specimen 2 | 9·15 | 4·25 | 11·11 | 10·13 | 39·54 | 10·46 | 11·11 | 4·25 |
| specimen 3 | 9·38 | 3·75 | 10·63 | 11·56 | 38·75 | 11·56 | 10·94 | 3·44 |
| specimen 4 | 9·87 | 4·14 | 9·24 | 11·78 | 39·17 | 11·78 | 9·87 | 4·14 |
| specimen 5 | 9·00 | 4·82 | 10·93 | 12·86 | 34·41 | 12·54 | 10·61 | 4·82 |
| mean | 9·77 | 4·22 | 10·23 | 11·46 | 38·29 | 11·41 | 10·34 | 3·98 |
| interval/*ab* | 2·32 | 1·00 | 2·42 | 2·72 | 9·07 | 2·70 | 2·45 | 0·94 |

Nephridia: in the forebody and anterior intestinal region meronephridia discharge presetally in each of *a*, *b*, *c* and *d* lines and between *d* line and the middorsum. Those discharging in *c* and *d* lie far below these loci and have very long ducts. It was not possible to demonstrate unequivocally that there were two nephridia at *a* as the external pores indicate. In the most anterior segment the ventral nephridia form small (exonephric ?) tufts and do not appear to be accompanied by the full complement of more dorsal nephridia ; in the intestinal region there is a preseptal funnel on each side near the nerve cord, this condition persisting to the caudal extremity ; median nephridia are not enlarged relative to others though they are moderately large. In the posterior region the dorsalmost nephridia discharge in an approximately straight line above, in or below *d* lines which are there irregular. In the midbody a small bladder-like dilatation (parasitic artefact ?) of a nephridial duct is sporadically present though most ducts do not reveal even an intramural bladder.

Holandric (funnels iridescent in X and XI) ; gymnorchous ; elongate racemose seminal vesicles in XI and XII, on the anterior septa ; similar structures of unknown function are present on the anterior septum of X (specimen 2) and of preceding segments, to at least V (lectotype). Metagynous ; ovisacs absent. Prostates restricted to XVIII, tongue shaped racemose but with a short narrower ectal portion prior to the duct and, in serial sections, revealing a single narrow central lumen with cuboidal epithelium. Vas deferens joining the ental end of the sinuous duct. Penial setae moderately slender, curved, needle like ; the tip tapering narrowly, simply but bluntly pointed ; ornamentation absent ; length = 1·2–1·4 mm ; general width = 13–14 $\mu$m (specimen 2). Spermathecae 2 pairs. Diverticulum single, clavate, uniloculate (specimen 2) or circumscribed by a furrow so that it has a slight tendency to be bifid (lectotype).

*Genital markings.* The location of genital markings in 11/12 (in contrast with 10/11 in the lectotype), 19/20 and 20/21 is constant in the 9 Fern Dene specimens; the markings in 20/21 are always more median than those in 19/20.

TYPE-LOCALITY. Emu Bay. Map, 7/2. Launceston. Map, 9/5.

MATERIAL EXAMINED.

Launceston, 147°10′E. 41°25′S. Map, 9/5, A. Simson, Feb 1892, NMV : G182 – lectotype. Fern Dene, Ironcliff Road, near Penguin, 146°05′E. 41°05′S. Map, 8/1, Collector ? 13 Oct 1954 – specimens 1–3 TM : K352–354; 4 BJ : T58; specimens 5 and 8 BM(NH) : 1973.2.29–30; specimens 6 and 7 AM : W5318–5319; specimen 9 BJ : T59.

REMARKS. The transversely papillate or punctate ventral genital marking in 10/11 or 11/12 is distinctive of this species. The presence of dorsal pores also distinguishes it from all Tasmanian species.

## Genus ***PSEUDOCRYPTODRILUS*** Jamieson, 1972b

DIAGNOSIS. A pair of combined male and prostatic pores on XVIII. Setae 8 per segment. *Nephridia 2 to 3 on each side excepting caudally where there is a single pair of stomate holonephridia in each segment.* Typhlosole weak or absent. Prostates depressed tubular.

DESCRIPTION. Terrestrial. Dorsal pores present. Setae commencing on II, in 8 longitudinal rows which may become irregular posteriorly. Ventral setal couples widely paired ($aa < 2ab$); setae of the dorsal couples widely separated, $cd > 2ab$ and approximately as far apart as the two setal couples of a side ($cd \doteqdot 0{\cdot}8$–$1{\cdot}1bc$); dorsal median intersetal distance approximately one-third of the circumference ($dd \doteqdot 0{\cdot}3u$). Setae *a* and *b* of XVIII replaced by penial setae. Nephropores inconspicuous. A pair of combined male and prostatic pores on XVIII; postclitellar. Spermathecal pores 2 pairs, in 7/8 and 8/9 or anteriorly in VIII and IX.

Dorsal blood vessel single, continuous onto the pharynx; last hearts in XII (latero-oesophageal). Subneural absent. Gizzard moderate to well developed, in V. Calciferous glands absent but oesophagus modified (dilated or internally rugose) in XV–XVI, XVII; intestinal origin XVIII or XIX; a low typhlosole present or absent. Anterior nephridia tuft-like or simple. Nephridia exonephric; in the anterior intestinal region 2 on each side; in the forebody 2 (*P. diaphanus*) or 3 (*P. acanthodriloides*, in which the median one is stomate); caudally holonephric, with a single stomate, avesiculate nephridium on each side. Holandric; gymnorchous; seminal vesicles in IX and XII. Prostates depressed tubular. Penial setae present. Metagynous; ovisacs present. Spermathecae with 1 or 2 clavate, uniloculate diverticula.

DISTRIBUTION. Eastern Subregion of Australia, southern faunal province: Victoria. Tasmania. (2 species.)

TYPE-SPECIES. *Megascolides diaphanus* Spencer, 1900.

TASMANIAN SPECIES. *P. acanthodriloides* sp. n.

REMARKS. The new species is included in the formerly monotypic *Pseudocryptodrilus* chiefly because it is a megascolecine which is meronephric anteriorly but

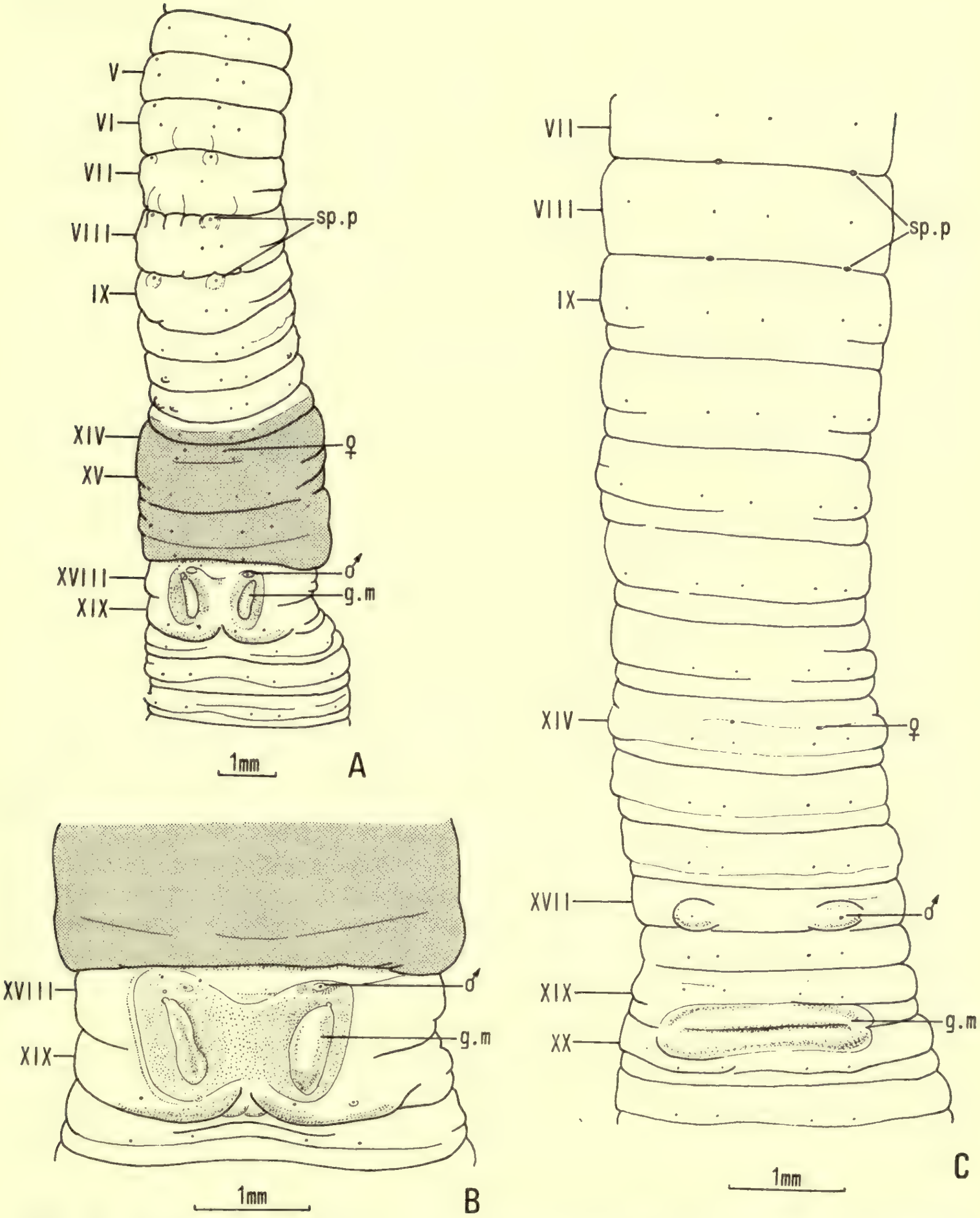

V
VI
VII
VIII
IX
sp.p
XIV
XV
♀
XVIII
XIX
♂
g.m
1mm
A
XVIII
XIX
♂
g.m
1mm
B
VII
VIII
IX
sp.p
XIV
♀
XVII
♂
XIX
XX
g.m
1mm
C

FIG. 26. Genital fields. A & B, *Pseudocryptodrilus acanthodriloides*, holotype: A, entire male field; B, detail of same. C, *Rhododrilus littoralis*, holotype.

holonephric caudally. This condition has presumably evolved from a fully holonephric condition and may have been convergently acquired in the two species but the genus as redefined above to include *acanthodriloides* is satisfactorily homogeneous, there being no variation which is not acceptable as intrageneric.

The longitudinal orientation of the accessory genital markings, constituting tubercula pubertatis, is highly unusual in the Megascolecidae and it is, therefore, remarkable that another Tasmanian species *Oreoscolex bidiverticulatus* (q.v.) has tubercula and an almost identical genital field. Either tubercula, so rare elsewhere, have been acquired independently in the two species or a special relationship exists between the two (i.e. common descent from a species with similar tubercula). A decision between the two alternatives cannot be made, at least on present evidence, but the morphology of the *Oreoscolex* species is not inconsistent with relationship. Origin of *Oreoscolex* (Megascolecini) in south-eastern Australia from local holonephric species or from species which, like *P. acanthodriloides*, were partly holonephric and partly meronephric is quite conceivable. Irrespective of its relationships, *Pseudocryptodrilus* presents a most interesting transition from the holonephric to the meronephric condition.

### ***Pseudocryptodrilus acanthodriloides*** sp. n.

Fig. 4, 26A, B, 32S ; Plates 61–63. Table 12

l = 70, 67 mm, w = 3·4, 3·2 mm, s = 127, 126.

Prostomium epitanylobous with grooved peristomium. First dorsal pore 4/5. Setae 8 per segment, in regular longitudinal rows throughout. Nephropores sporadically visible in *a*, *b* and *d* lines. Clitellum annular, ½XIII–XVII (holotype ; not developed in paratype 1). Male pores on XVIII in *a*. A pair of longitudinal ridges (tubercula pubertatis) present, each occupying *ab* and extending from just behind each male pore to the setal arc of XIX ; the pair of tubercula, with the male pores, lying on a whitish glandular tumescence ; a similar additional pair of tubercula extending from the male pores to the setal arc of XVII in some specimens (see field variation). Female pores a pair shortly anteromedian to *a* of XIV. Spermathecal pores 2 pairs, at the anterior margins of VIII and IX, but not in the intersegments, each on a hemispherical papilla ; the ventral surface of segments VII–IX and posterior VI tumid.

TABLE 12

Intersetal distances in segment XII in *Pseudocryptodrilus acanthodriloides*

mm

| | *aa* | *ab* | *bc* | *cd* | *dd* | *dc* | *cb* | *ba* |
|---|---|---|---|---|---|---|---|---|
| holotype | 0·9 | 0·5 | 0·9 | 0·9 | 2·2 | 0·9 | 0·9 | 0·5 |
| paratype 1 | 0·9 | 0·4 | 0·8 | 0·9 | 1·8 | 0·9 | 0·8 | 0·4 |
| paratype 2 | 0·9 | 0·4 | 0·8 | 0·8 | 1·7 | 0·8 | 0·8 | 0·4 |
| paratype 3 | 0·8 | 0·4 | 0·8 | 1·0 | 1·8 | 1·0 | 0·8 | 0·4 |
| paratype 4 | 0·9 | 0·4 | 1·0 | 0·9 | 2·0 | 0·9 | 1·0 | 0·4 |

Table 12 (*cont.*)

| | standardized ($u$ = 100) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | *aa* | *ab* | *bc* | *cd* | *dd* | *dc* | *cb* | *ba* |
| holotype | 12·04 | 6·02 | 11·57 | 12·04 | 28·70 | 12·04 | 11·57 | 6·02 |
| paratype 1 | 12·56 | 6·03 | 12·06 | 12·56 | 26·13 | 12·56 | 12·06 | 6·03 |
| paratype 2 | 13·83 | 6·38 | 11·70 | 12·23 | 25·53 | 12·23 | 11·70 | 6·38 |
| paratype 3 | 11·44 | 5·97 | 11·94 | 13·43 | 25·87 | 13·43 | 11·94 | 5·97 |
| paratype 4 | 11·90 | 5·71 | 12·86 | 11·90 | 27·14 | 11·90 | 12·86 | 5·71 |
| mean | 12·35 | 6·02 | 12·03 | 12·43 | 26·67 | 12·43 | 12·03 | 6·02 |
| interval/*ab* | 2·05 | 1·00 | 2·00 | 2·06 | 4·43 | 2·06 | 2·00 | 1·00 |

Last hearts in XII (latero-oesophageal). Supra-oesophageal in VII–XII, weakly developed. Gizzard moderate, muscular but easily compressible in V. Extramural calciferous glands absent, longitudinal rugae well developed, though not forming laminae, in XV and XVI. Intestinal origin ½XVIII ; typhlosole absent.

Nephridia : exonephric much coiled, tuft-like nephridia in II, III and IV discharging by simple ducts presetally in *c* and or *d* lines. Further posteriorly simple avesiculate nephridia discharging presetally in association with setal lines, apparently not all 4 setal lines in any one segment (*a*, *b* and *d* in the holotype in which the median-most nephridium is seen to have a preseptal funnel). In the anterior intestinal region 2 nephridia on each side, discharging presetally in *b* and *d* lines. Caudally with a pair of stomate, avesiculate holonephridia only, in each segment, discharging presetally in *d* lines (holotype and paratype 1). Holandric (funnels iridescent in X and XI) ; gymnorchous ; seminal vesicles racemose, in IX and XII. Metagynous ; small ovisacs in XIV. Prostates flattened, tubular, tortuous, in XVIII and XIX ; vas deferens joining junction of gland and duct. Penial setae moderately slender but relatively short, only slightly curved, the ectal extremity flattened like the blade of an oar ; ornamentation a few deep half-encircling jagged scars ; length = 0·6 mm ; general width of shaft = 10 $\mu$m (paratype 3). Spermathecae, 2 pairs ; diverticulum single, clavate, uniloculate.

*Genital markings.* Of 13 paratypes, 3 (paratypes 1, 7, 12) have male fields as the holotype, with genital markings restricted to a pair of tubercula extending from ½XVIII into XIX ; 6 paratypes (2, 3, 4, 5, 11 and 13) have these tubercula augmented solely by a pair (unilateral only in paratypes 3, 11 (R) and 13 (L)) extending from approximately ½XVIII–½XVII which lie in the same tumid area as the posterior pair ; in 1 paratype (8) the posterior tubercula are present but there is also a mid-ventral circular presetal glandular patch in XVIII and a similar postsetal patch in XVII ; 1 paratype (10) has the posterior tubercula and only the midventral presetal patch in XVIII ; while 1 (paratype 6) has this condition, and also the anterior paired tubercula, and 1 (paratype 9) is similar to paratype 6 but lacks the left anterior tubercula. Most specimens have ventral tumescence in VII–IX and some in VI also.

MATERIAL EXAMINED.

Great Lake, shore under decaying gum leaves, 146°45′E. 41°55′S. Map, 8/2, Dr J. L. Hickman, 26 May 1954 – holotype TM : K355 ; paratypes 1, 11 and 13 BM(NH) : 1973.2.31–33 ; paratypes 2–5 TM : W356–359 ; paratypes 6, 8–10 BJ : T60, 61–63 ; paratypes 7 and 12 AM : W5320–5321.

REMARKS. The male genital field distinguishes this species from *P. diaphanus*.

## Tribe **DICHOGASTRINI** Jamieson, 1971a

## Genus ***HICKMANIELLA*** gen. nov.

Diagnosis. Combined male and prostatic pores a pair on XVIII. An oesophageal and an intestinal gizzard present. Nephridia few exonephric avesiculate meronephridia per segment; the medium nephridium with preseptal funnel. Prostates tubuloracemose. Spermathecae 2 pairs.

Description. Terrestrial. Form circular in cross section; anus terminal. Dorsal pores present. Setae numerous in each segment ($>$ 30 in posterior segments); ventral gap large; dorsal gap recognizable anteriorly, inappreciable caudally ($zz \doteqdot zy$). Nephropores not externally visible. Clitellum annular; anterior to the male porophores. Combined pores of the vasa deferentia and a pair of tubuloracemose prostates one pair on XVIII. Female pores a pair on XIV. Spermathecal pores 2 pairs, in intersegments 7/8 and 8/9.

Last hearts in XII (latero-oesophageal). Subneural vessel absent. Oesophageal gizzard in V. Extramural calciferous glands absent. Intestine commencing in the vicinity of the prostate glands; with a very thick-walled intestinal gizzard preceded by a thin-walled crop; typhlosole and caeca absent. Few, exonephric, avesiculate meronephridia per segment, the median nephridium in oesophageal and intestinal regions with preseptal funnel; tufting and enteronephry absent. Holandric; gymnorchous; seminal vesicles in IX and XII. Metagynous; ovisacs absent. Penial setae present. Spermathecae with clavate but internally multiloculate diverticulum.

Type-species. *Hickmaniella opisthogaster* sp. n.

Distribution. Northwest Tasmania. (Monotypic.)

Remarks. *Hickmaniella* is almost unique in the known Megascolecidae in possessing an intestinal gizzard. (*Pleionogaster* has 3 or 4 such gizzards.) This feature is characteristic of the Oriental family Moniligastridae (in which, however, Gates (1962) states the gizzards are actually oesophageal though post-ovarian), the holarctic family Lumbricidae and the palaearctic, neotropical and Ethiopian subfamily Alminae of the non-Australian family Glossoscolecidae. The Moniligastridae (Order Moniligastrida) differ from Megascolecids in many significant respects, including the single-layered clitellum, large-yolked eggs, presence of intra-septal testis sacs, location of one or two pairs of male pores in the next segment or segments respectively and absence of an anterior gizzard. The Lumbricidae are distinguished by the absence of an oesophageal gizzard, location of the male pores in or in front of segment XV, location of the clitellum far behind these pores, the exclusively lumbricine setae and in other respects. In contrast, the Glossoscolecidae, while showing their closest affinities with the Lumbricidae (*vide* Jamieson 1971d), show notable resemblances to the Megascolecidae which may indicate that they are more closely related to the latter than is any other family with the exception of the Eudrilidae. The intestinal gizzard of *Hickmaniella* constitutes a further link between the Megascolecidae and the Glossoscolecidae. Like many other common features of the two families the intestinal gizzard may have been independently acquired in each but sufficient similarities exist to suggest that if this be the case we have here a case of parallelism in evolution stemming from a common, though remote, ancestry rather than convergence in relatively unrelated lineages of the order Haplotaxida. These similarities include the following (in addition to general characteristics of the non-Alluroidid Lumbricina of Brinkhurst and Jamieson 1971) : progression from the lumbricine to the perichaetine arrangement of setae ; presence of prostate-like glands in some Glossoscolecidae which resemble the prostates of the Megascolecidae ; frequent presence in both families of oesophageal gizzards and the mutual possession of intestinal gizzards ; location of the male pores in XVIII in some Glossoscolecidae, as in most Megascolecidae ; location of these pores on the clitellum in some Megascolecidae as in many Glossoscolecidae and finally replication of the nephridia, in *Tritogenia*, as in many Megascolecids. While inclusion, on the one hand, of the Glossoscolecidae and Lumbricidae in the superfamily Lumbricoidea and, on the other hand, of the Megascolecidae and Eudrilidae in the superfamily Megascolecidae is here upheld, the above-mentioned similarities between the parent families Megascolecidae and Glossoscolecidae bring the two families closer together and endorse recognition of the suborder Lumbricina as a natural grouping. The Alluroididae included in it by Brinkhurst and Jamieson (1971) relate the suborder to other Haplotaxid suborders, especially the Haplotaxina.

### ***Hickmaniella opisthogaster*** sp. n.

Fig. 4, 18A, 32C, D ; Plates 64–66

l = 61, 59 mm, w = 5·5, 5·0 mm, s = 87, 82.

Prostomium canaliculate, tanylobous. First dorsal pore 4/5. Setae on XII 32 (holotype) or 49 (paratype 1) ; caudally 31 to 38 per segment ; *aa* regular throughout (holotype) or becoming irregular posteriorly (paratype 1) ; anteriorly *aa* ÷ 5*ab* ; caudally *aa* ÷ 3*ab* ; *zz* varying from 2–2·5*zy*, anteriorly, to 1–1·5*zy* caudally. Nephropores not externally visible. Clitellum annular, XIII–½XVII. Male pores approximately in *a* lines of XVIII, each median to a penisetal pore, on prominent dome-shaped medianly almost contiguous papillae which expand the segment longitudinally. Accessory genital markings paired, medianly conjoined oval glandular prominences with papillate or pore-like centres in approximately *b* lines in intersegments 11/12, 15/16 and 20/21, resembling the male porophores in appearance ; an additional similar marking unilateral on the left, in 14/15, and on the right, in 21/22 in paratype 1. Female pores paired, anterior to setae *a* on XIV. Spermathecal pores 2 inconspicuous pairs, in 7/8 and 8/9, in *a* lines.

Last hearts in XII (hearts in X–XII latero-oesophageal, with connective from dorsal and supra-oesophageal vessel ; supra-oesophageal vessel recognizable in ½VII–½XIV, moderately developed). Oesophageal gizzard moderate, in V. Extramural calciferous glands absent. Intestine commencing in XVIII in which it is thin-walled and crop-like (holotype, paratype 1) ; a very large, extremely thick-walled intestinal gizzard in XIX (holotype) or XX (paratype 1) ; typhlosole absent. Few, exonephric, avesiculate meronephridia per segment, commencing in II ; 3 on each side in the intestinal region ; median nephridium with preseptal funnel in intestinal and at least the posterior oesophageal segments ; tufting and enteronephry absent.

Holandric ; gymnorchous ; seminal vesicles in IX and XII. Metagynous ; ovisacs absent. Prostates tubuloracemose, extending laterally in, and restricted to, XVIII ; with very narrow central lumen wihch bears narrower epithelium-lined side branches. Penial setae (holotype) 2 mature and 1 completely developed on each side ; when functional 1·6–1·7 mm long, general width of shaft 31 μm ; gently or strongly curved, widened basally, the ectal tip flattened, usually curved, and with margins slightly inrolled ; the ectal region of the shaft, but not the inrolled region, ornamented by numerous short, transverse minutely serrated linear markings of which there are 4 or more across the width of the seta ; this ornamentation readily visible under the higher powers of the light microscope without recourse to oil immersion. Spermathecae 2 pairs, in VIII and IX ; a single clavate but internally multiloculate diverticulum ; the duct with a large dorsal swelling.

*Genital markings.* The four mature paratypes (1, 3–5) resemble the holotype in having paired intersegmental genital markings in 11/12, 15/16 and 20/21. In addition paratype 1 has unilateral genital markings in 14/15 (left) and 21/22 (right) resembling the other markings.

Material examined.

Parrawe, 145°35′E. 41°20′S. Map, 7/3, Dr J. L. Hickman, 25 Aug 1954 – holotype TM : K360 ; paratype 1 BM(NH) : 1973.2.34 ; paratype 2 TM : K361. Table Cape, 145°45′E. 41°00′S. Map, 7/1, Dr J. L. Hickman, 24 Aug 1954 – paratypes 3 and 4 AM : W5322–5323. Hellyer Gorge, 145°35′E. 41°20′S. Map, 7/3, Dr J. L. Hickman, 28 May 1954 – paratype 5 BJ : T64.

## Tribe **MEGASCOLECINI** s. Jamieson, 1971a

### Genus ***OREOSCOLEX*** Jamieson, 1973a

Diagnosis. Setae 8 per segment. A pair of combined pores of vasa deferentia and racemose or tubuloracemose prostates on XVIII. Gizzard in V. Extramural calciferous glands and typhlosole present or absent. Meronephric ; anterior nephridia astomate, avesiculate and exonephric, or enteronephric, usually tufted ; *caudal nephridia* avesiculate, exonephric (or enteronephric ?), *with numerous preseptal funnels on each side in each segment.* Spermathecae in 2 or 3 segments, paired or median ; diverticula uniloculate or multiloculate.

Description. Terrestrial worms. Form circular in cross section ; anus terminal. Prostomium prolobous to tanylobous. Dorsal pores present, commencing in 3/4–20/21. Setae 8 per segment, in regular longitudinal rows throughout or becoming irregular posteriorly. Setal ratios very variable $aa : ab : bc : cd : dd =$ 1·9–3·4 : 1 : 1·5–5·9 : 1·6–3·4 : 3·1–12·9 ; $dd : u =$ 0·11–0·58 ; $cd =$ or $<$ never significantly $> bc$. Clitellum annular or less commonly saddle shaped, occupying 4–6½ segments, its posterior limit in XVII–XIX. Combined pores of the vasa deferentia and a pair of prostates in XVIII ; the prostates externally racemose or lobulated tubular, in the former case with or without, in the latter always with an axial lumen; this lumen possessing side branches. Female pores a pair, anteromedian of setae *a*, in XIV. Spermathecal pores unpaired posteriorly in VII and VIII (*O. imparicystis*) or paired in 6/7, 7/8–8/9. Last hearts in XII or (*O. bidiverticulatus*) XIII; latero-oesophageal hearts (always ?) with connectives from dorsal and supra-oesophageal vessels. Subneural vessel absent. Gizzard large, in V. Oesophagus with internal rugae, or laminae, or extramural calciferous glands, intestine commencing in XVI, XVII or XVIII; typhlosole absent (*O. peculiaris*), rudimentary or well developed, commencing 1½–8 segments behind the intestinal origin. Meronephric; anterior nephridia astomate, avesiculate and exonephric, or enteronephric (entering pharynx and buccal cavity), usually tufted; caudal nephridia avesiculate, with numerous preseptal funnels on each side in each segment and exonephric or (*O. imparicystis*) possibly enteronephric. Holandric with seminal vesicles in IX and XII or rarely in XI and XII or (*O. imparicystis, leai*) XII only; or (*peculiaris*) with anterior male organs reduced (incipiently metandric) gymnorchous (testis-sacs absent). Metagynous (ovaries in XIII); ovisacs present or absent. Vasa deferentia joining the muscular duct of the prostate at midlength or entally, or the ectal extremity of the gland. Penial setae present or (*imparicystis*) absent. Spermathecae with one or two uniloculate or multiloculate diverticula.

TYPE-SPECIES. *Oreoscolex imparicystis* Jamieson 1973a. New South Wales.

DISTRIBUTION. Eastern Subregion of Australia: New South Wales and Tasmania.

### *Tasmanian species*

*O. bidiverticulatus* sp. n.
**O. campestris* (Spencer, 1895)
**O. irregularis* (Spencer, 1895)
**O. leai* (Michaelsen, 1910)
*O. longus* sp. n.
*O. peculiaris* sp. n.
*O. sexthecatus* sp. n.
**O. wellingtonensis* (Spencer, 1895)

### *Other species*

Four species from New South Wales (examined by the author as indicated) in addition to the type-species. The additional species accord exactly with the generic diagnosis but detailed generic characterization is not attempted here.

**Notoscolex grandis* Fletcher, 1887a 'Cotypes' AM : W.1494.
**Cryptodrilus illawarrae* Fletcher, 1889a Mt Kembla AM : W.1311.
**Cryptodrilus saccarius* Fletcher, 1887b 'Cotypes' AM : W.1372.
**Cryptodrilus simulans* Fletcher, 1889b Syntypes AM : W.1499.

* Comb. nov.

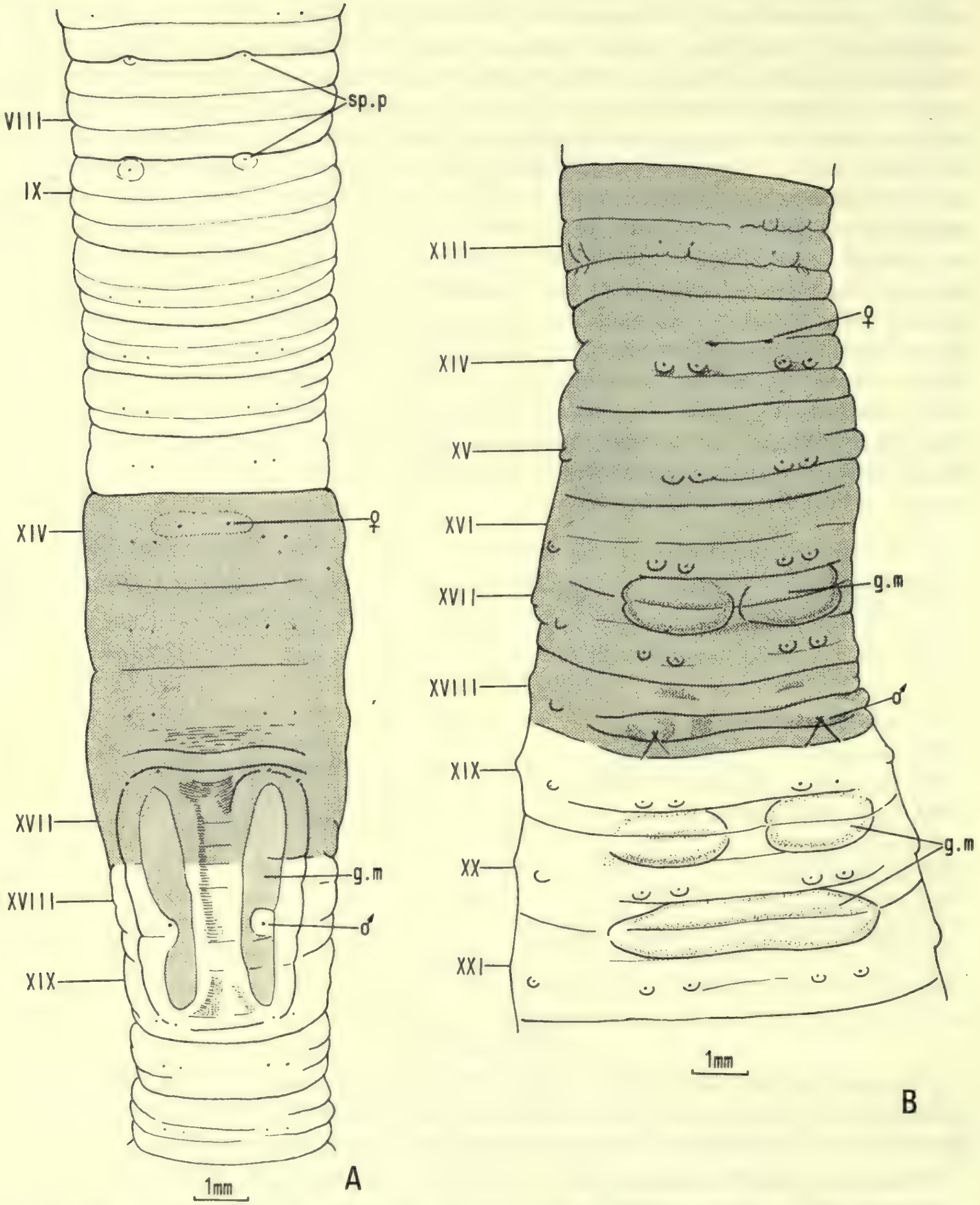

sp.p
VIII
IX
XIV
♀
XVII
g.m
XVIII
♂
XIX
1mm
A
XIII
♀
XIV
XV
XVI
XVII
g.m
XVIII
♂
XIX
XX
g.m
XXI
1mm
B

FIG. 27. Genital fields. A, *Oreoscolex bidiverticulatus*, holotype. B, *O. longus*, holotype.

### KEY TO TASMANIAN SPECIES OF *OREOSCOLEX*

1 Spermathecal diverticula uniloculate . . . . . . . . . . 2
– Spermathecal diverticula multiloculate . . . . . . . . . . 5
2 Male pores in *ab* on XVIII . . . . . . . . . . . 3
– Male pores median to *a* on XVIII . . . . . . . . . . . 4
3 Reniform extramural calciferous glands in XV and XVI. Fig. 27A **O. bidiverticulatus** sp. n.
– Extramural calciferous glands absent. Fig. 27B . . . . . . **O. longus** sp. n.
4 Male pores almost contiguous medianly, on a circular porophore median to *b* lines. A median genital marking in 20/21. Fig. 28C . . **O. irregularis** (Spencer, 1895)
– Male pores shortly median to *a* lines on a transverse oval porophore which extends lateral of *b* lines and impinges on adjacent segments. Fig. 28B . **O. peculiaris** sp. n.
5 Spermathecae 3 pairs. Fig. 29A . . . . . . . **O. sexthecatus** sp. n.
– Spermathecae 2 pairs . . . . . . . . . . . . 6
6 A pair of eye-like genital markings present in *ab* in 17/18 or XVII and in each of several intersegments behind XVIII. Fig. 28A . **O. campestris** (Spencer, 1895)
– Eye-like or other paired genital markings absent . . . . . . . . 7
7 A large median transverse genital marking in each of intersegments 15/16–18/19, extending approximately to *b* lines. That in 18/19 indistinct; that in 17/18 indistinct posteriorly . . . . . . . . **O. leai** (Michaelsen, 1910)
– A large midventral glandular pad in 19/20 or 20/21 extending laterally beyond *b* lines. Fig. 29B . . . . . . **O. wellingtonensis** (Spencer, 1895)

## *Oreoscolex bidiverticulatus* sp. n.

Fig. 3, 27A, 32J; Plate 67. Table 13

l = 150, 106 mm, w = 4·9, 4·2 mm, s = 118, 141.

Prostomium epilobous $\frac{1}{3}$, open. First dorsal pore 4/5. Setae 8 per segment in regular longitudinal rows throughout. Nephropores not visible. Clitellum annular ($\frac{1}{2}$XIII dorsally) XIV–XVII; not developed in paratype 1. Male pores on XVIII, in *ab*, on long tubercula pubertatis which extend from the setal arc of XVII to that of XIX; a glandular depression occupying the space between the tubercula. Female pores paired anteromedian of *a* on XIV. Spermathecal pores 2 pairs, in 7/8 and 8/9, on small papillae in *a*.

TABLE 13

Intersetal distances in segment XII in *Oreoscolex bidiverticulatus*

mm

| | *aa* | *ab* | *bc* | *cd* | *dd* | *dc* | *cb* | *ba* |
|---|---|---|---|---|---|---|---|---|
| holotype | 1·8 | 0·6 | 1·7 | 1·1 | 4·4 | 1·1 | 1·8 | 0·5 |
| paratype 1 | 1·5 | 0·5 | 1·4 | 1·0 | 4·0 | 1·0 | 1·4 | 0·5 |

standardized ($u$ = 100)

| | *aa* | *ab* | *bc* | *cd* | *dd* | *dc* | *cb* | *ba* |
|---|---|---|---|---|---|---|---|---|
| holotype | 14·02 | 4·58 | 12·94 | 8·63 | 33·42 | 8·63 | 13·75 | 4·04 |
| paratype 1 | 13·54 | 4·31 | 12·31 | 8·92 | 35·38 | 8·92 | 12·31 | 4·31 |
| mean | 13·78 | 4·45 | 12·63 | 8·78 | 34·40 | 8·78 | 13·03 | 4·18 |
| interval/*ab* | 3·10 | 1·00 | 2·84 | 1·97 | 7·73 | 1·97 | 2·93 | 0·94 |

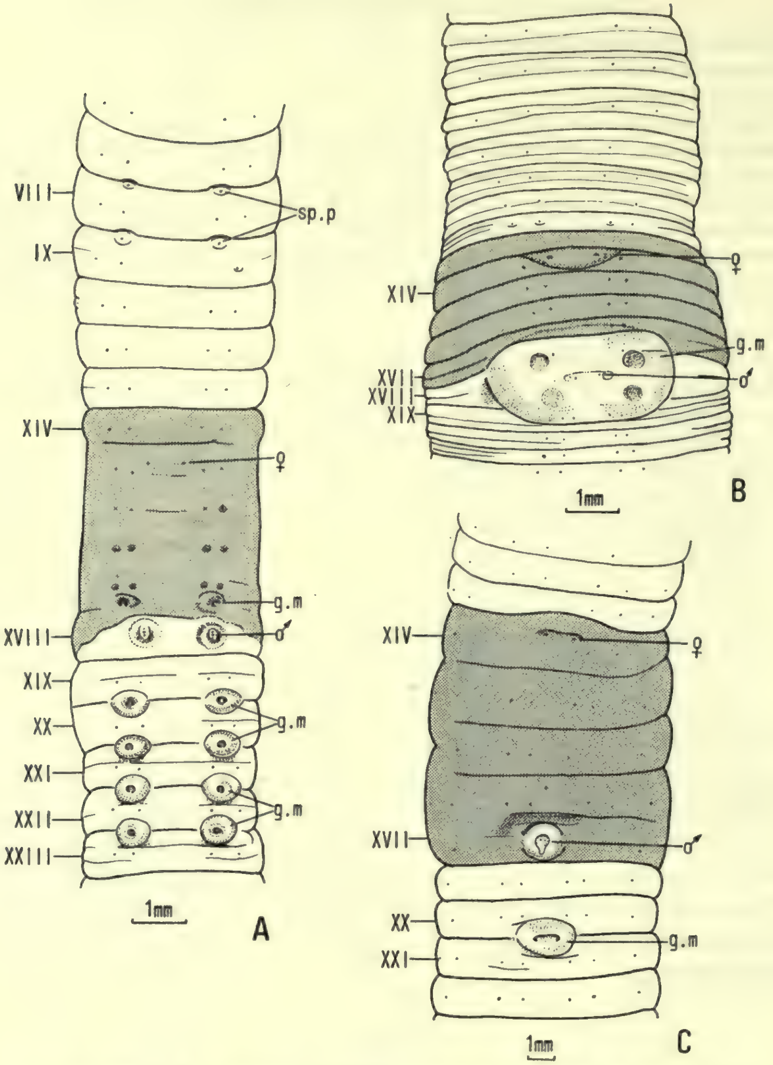

VIII
sp.p
IX
XIV
♀
g.m
XVIII
♂
XIX
XX
g.m
XXI
XXII
g.m
XXIII
1mm
A
♀
XIV
g.m
XVII
XVIII
XIX
♂
1mm
B
XIV
♀
XVII
♂
XX
g.m
XXI
1mm
C

FIG. 28. Genital fields. A, *Oreoscolex campestris*, specimen 1. B, *O. peculiaris*, holotype. C, *O. irregularis*, specimen 1.

Last hearts in XIII (latero-oesophageal); supra-oesophageal in VII–½XIV, moderately developed. Gizzard large and firm, in V, with anterior rim. A pair of large reniform extramural calciferous glands in each of segments XV and XVI, each joined over most of its height to the lateral wall of the oesophagus, free for only a short extent dorsally, and ventrally, and with a wide communication with the central lumen of the oesophagus; sessile, lacking a duct. Each gland with numerous radial longitudinal laminae which span the lumen of the free part of the gland.

Intestinal origin XVIII but no constricted oesophageal valve at 17/18; deep dorsal typhlosole commencing in XXIII, continued anteriorly as a slight ridge to XIX. In II–VII with a pair of exonephric tufted nephridia with numerous anteriorly running ducts (always ?) opening in the same segment; the tufts largest in V and VI and very large in V. Few exonephric meronephridia on each side in succeeding segments until in XV and XVI there are very deep lateral bands of exonephric nephridia, each with several tubules, with the appearance of transverse tufts; meronephridia again few in more posterior segments; caudally numerous exonephric meronephridia on each side dependent from the anterior septum and with many preseptal funnels in a transverse row. Holandric (funnels iridescent in X and XI); seminal vesicles racemose, in IX and XII. Metagynous; ovisacs present. Prostates racemose; restricted to an enlarged segment XVIII: with (paratype 2) branched internal ducts and lacking a central lumen. Penial seta almost straight, filiform, tapering ectally, lacking ornamentation; the tip broadened, irregular and bent relative to the axis; length left seta = 1·1 mm, general width of shaft = 12 μm (holotype). Spermathecae 2 pairs; each with 1 (paratype 1) or 2 (holotype) (inseminated) clavate, uniloculate diverticula.

MATERIAL EXAMINED.

Fern Glade, Emu River, Burnie, 145°55′E. 41°05′S. Map, 7/2, Dr J. L. Hickman, 24 Aug 1954 – holotype TM: K362; paratype 1 BM(NH): 1973.2.35; paratype 2BJ: T65.

REMARKS. Intraspecific variation from one to two diverticula on a spermatheca is highly unusual in the Oligochaeta but there is no doubt that the holotype and paratypes are conspecific. Location of last hearts in XIII and of calciferous glands in XV and XVI, together with the configuration of the genital markings, is diagnostic of this species.

## ***Oreoscolex campestris*** (Spencer, 1895)

Fig. 3, 28A, 32K; Plates 68–72. Table 14

*Cryptodrilus campestris* Spencer, 1895: 39, Pl. II, fig. 13–15.
*Notoscolex campestris*; Michaelsen, 1900: 192; Jamieson, 1971c: 78.

l = 87, 82 mm, w = 3·5 mm, s = 109, 114 (specimens 1 and 2). (l = 50–75 mm, w = 3 mm, Spencer.)

TABLE 14

Intersetal distances in segment XII in *Oreoscolex campestris*

mm

| | *aa* | *ab* | *bc* | *cd* | *dd* | *dc* | *cb* | *ba* |
|---|---|---|---|---|---|---|---|---|
| specimen 1 | 1·4 | 0·4 | 2·1 | 1·1 | 1·6 | 1·1 | 2·2 | 0·4 |
| specimen 2 | 1·5 | 0·5 | 2·5 | 1·0 | 1·1 | 1·0 | 2·5 | 0·4 |
| specimen 3 | 1·1 | 0·3 | 1·4 | 0·8 | 1·0 | 0·9 | 1·6 | 0·3 |
| specimen 4 | 1·6 | 0·5 | 2·4 | 1·1 | 1·6 | 1·2 | 2·3 | 0·5 |
| specimen 5 | 1·4 | 0·5 | 2·3 | 1·0 | 1·4 | 1·0 | 2·5 | 0·4 |

Table 14 (*cont.*)

| | standardized ($u$ = 100) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | *aa* | *ab* | *bc* | *cd* | *dd* | *dc* | *cb* | *ba* |
| specimen 1 | 13·79 | 4·14 | 20·00 | 11·03 | 15·17 | 10·34 | 21·38 | 4·14 |
| specimen 2 | 14·19 | 4·73 | 23·65 | 9·46 | 10·81 | 9·46 | 23·65 | 4·05 |
| specimen 3 | 15·00 | 4·00 | 19·00 | 11·00 | 14·00 | 12·00 | 22·00 | 4·00 |
| specimen 4 | 14·19 | 4·52 | 21·29 | 9·68 | 14·19 | 10·97 | 20·64 | 4·52 |
| specimen 5 | 13·50 | 4·73 | 21·60 | 9·45 | 13·50 | 9·45 | 23·63 | 4·05 |
| mean | 14·13 | 4·42 | 21·11 | 10·12 | 13·53 | 10·44 | 22·26 | 4·15 |
| interval/*ab* | 3·20 | 1·00 | 4·78 | 2·29 | 3·06 | 2·36 | 5·04 | 0·94 |

Prostomium indistinctly tanylobous, canaliculate (epilobous ⅓, Spencer). First drosal pore 4/5 (3/4 Spencer). Setae 8 per segment in regular longitudinal rows throughout, *dd* narrowing caudally. Nephropores not externally visible. Clitellum annular, XIII–½XVIII (XIII–XVII, saddle shaped in XVII, Spencer). Male pores in or median to *a* on XVIII on a pair of low circular porophores ; each pore preceded and succeeded, on the porophore, by the pore of a penisetal follicle. Paired eye-like genital markings occupying *ab* at 17/18, 19/20, 20/21, 21/22 (specimens, 1, 2) and 22/23 (specimen 1). (Anterior XVII, 18/19 and 19/20, Spencer.) Female pores, paired, anteromedian of *a* on XIV. Spermathecal pores two pairs on hemispheroidal papillae at the anterior margins of VIII and IX, just lateral of *a*. Last hearts in XII (latero-oesophageal). Supra-oesophageal in VIII–½XIII, well developed. Gizzard firm and very large, in V. Extramural calciferous glands absent ; oesophagus internally rugose in ?, X–XV. Intestinal origin ½XVI (XVI, Spencer) ; a very deep ⊥-shaped dorsal typhlosole commencing in XIX. Nephridia : very large pharyngeal tufts in IV and V ; smaller anterior tufts apparently exonephric ; caudally with a transverse row of numerous preseptal funnels on each side, the nephridia exonephric. Holandric (funnels iridescent in X and XI) ; gymnorchous ; seminal vesicles racemose, in IX and XII. Metagynous ; ovisacs present in XIV (?).

Genital markings in 18 specimens of *Oreoscolex campestris*

| Genital markings | Specimen | Total number of specimens |
|---|---|---|
| 16/17 | 16 | 1 |
| 17/18 | 1–18 | 18 |
| 18/19 | 5, 13, 14 (L), 18 | 4 |
| 19/20 | 1–18 | 18 |
| 20/21 | 1–18 | 18 |
| 21/22 | 1–3, 7–11, 12 (L), 14, 16–18 | 13 |
| 22/23 | 1 | 1 |

Prostates restricted to an enlarged segment XVIII ; broad flattened smooth lobes, each with 3 serial portions joined together by narrow alternating bands and probably originating from a tubular type ; the two glands completely encircling and adpressed to the intestine and to each other middorsally ; central lumen very narrow, with few lateral branches ; vas deferens joining the muscular prostate duct at its junction with the gland. Penial setae gently curved, moderately stout, slightly tapering ectally, the tip truncated and fluted by longitudinal grooves ; the ectal region ornamented with the exception of the vicinity of the tip ; ornamentation consisting of numerous regularly spaced circlets of large acute flattened spines the bases of which are in contact with adjacent spines in the circlet, some spines bifid, most simple : length of a functional seta = 0·34 mm ; general width of shaft = 13 μm (2 specimens). Spermathecae 2 pairs ; diverticulum single, sessile, multiloculate.

Type-locality. Parattah. Map, 14/1.

Material examined.

Parattah, under moss, in earth at base of cliff, also in earth along edges of logs, 147°25′E. 42°20′S. Map, 14/1, Professor V. V. Hickman and Dr J. L. Hickman, 18 Aug 1954 – specimens 1, 3–6 TM : K363–367 ; specimens 2, 7–11 BM(NH) : 1973.2.36–41 ; specimens 12–16 AM : W5324–5328 ; specimens 17 and 18 BJ : T66–67.

Remarks. The syntypes, in the National Museum of Victoria, G48, are desiccated, and yield no significant taxonomic information.

## ***Oreoscolex irregularis*** (Spencer, 1895)

Fig. 3, 28C, 32L. Table 15

*Cryptodrilus irregularis* Spencer, 1895 : 34–35, Pl. 1 fig. 1–3.
*Notoscolex irregularis* ; Michaelsen, 1900 : 191 ; Jamieson, 1971c : 79.

l = 194, 195 mm, w = 9 mm, s = 120, 136 mm (specimens 1 and 2 throughout this account).

Prostomium epilobous ⅔ (*ca.* ½, Spencer) canaliculate, open, parallel-sided. First dorsal pore 4/5. Setae 8 per segment ; all rows becoming irregular near the caudal extremity (or from XIV, Spencer) ; setae *a* and *b* absent in XVIII although their loci are lateral of the male pores. Clitellum annular XIV–XVIII ; some clitellar modification dorsally throughout XIII ; dorsal pores occluded, setae and intersegmental furrows retained though fainter than elsewhere. Male pores minute, almost contiguous medianly, in a circular depression (with, in specimen 1, posterior extension, i.e. pyriform), on a low median circular porophore which almost fills segment XVIII longitudinally and extends to *a* lines laterally. A transversely oval median accessory genital marking with crater-like centre, in 20/21, extending slightly lateral of *a* lines and almost reaching the setal arcs of XX and XXI. Female pores a pair, anteromedian to setae *a* of XIV. Spermathecal pores not demonstrable externally ; from internal dissection, well median of *a* lines if not medianly united, but said by Spencer to be in *a* lines.

Table 15

Intersetal distances in segment XII in *Oreoscolex irregularis*

mm

| | *aa* | *ab* | *bc* | *cd* | *dd* | *dc* | *cb* | *ba* |
|---|---|---|---|---|---|---|---|---|
| specimen 1 | 2·2 | 1·1 | 1·9 | 1·7 | 14·4 | 1·7 | 1·9 | 1·1 |
| specimen 2 | 2·6 | 1·3 | 1·7 | 1.2 | 15·0 | 1·2 | 1·7 | 1·3 |
| specimen 3 | 2·6 | 1·3 | 2·1 | 2·6 | 15·7 | 2·6 | 2·0 | 1·3 |
| specimen 4 | 2·8 | 0·9 | 1·5 | 2·1 | 13·9 | 1·9 | 1·5 | 0·9 |

Table 15 (*cont.*)

| | standardized (*u* = 100) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | *aa* | *ab* | *bc* | *cd* | *dd* | *dc* | *cb* | *ba* |
| specimen 1 | 8·49 | 4·11 | 7·40 | 5·58 | 55·35 | 6·58 | 7·12 | 4·11 |
| specimen 2 | 9·86 | 4·93 | 6·58 | 4·66 | 57·54 | 4·66 | 6·58 | 4·93 |
| specimen 3 | 8·53 | 4·27 | 6·87 | 8·53 | 52·14 | 8·53 | 6·64 | 4·27 |
| specimen 4 | 10·88 | 3·63 | 5·86 | 8·37 | 54·41 | 7·25 | 5·86 | 3·63 |
| mean | 9·44 | 4·24 | 6·68 | 7·04 | 54·86 | 6·76 | 6·55 | 4·24 |
| interval/*ab* | 2·23 | 1·00 | 1·58 | 1·66 | 12·94 | 1·59 | 1·54 | 1·00 |

Dorsal vessel single, continuous onto the pharynx. Last hearts in XII (hearts in X–XII latero-oesophageal, with dorsal and larger supra-oesophageal connectives); supra-oesophageal in VIII–½XIII, well developed. Gizzard large but easily compressible in V; oesophagus dilated and vascularized and internally rugose in IX–XV (–XIII, Spencer), but calciferous glands absent. Intestinal origin posterior in XVII (in XVIII, Spencer); typhlosole rudimentary, commencing in XXV; muscular thickening and caeca absent. Nephridia: large tufts in II–IX, especially large in II and III; those in V–IX exonephric by composite ducts in their own segments; those in IV sending composite ducts forwards, to the vicinity of the pharynx or, II and III, of the buccal cavity; some tufting of median nephridia persists to XIII and in II–XIII there are no nephridia lateral to the median nephridium. In XIV the nephridia begin to spread laterally to form a parietal band of astomate, avesiculate, exonephric micromeronephridia and by XIV these bands are well developed and so dense as to have the appearance of transversely expanded tufts, though with numerous separate parietal ducts in the same segment. Caudally with transverse bands of 30–40 avesiculate exonephric parietal micromeronephridia on each side, each with a minute, preseptal funnel.

Holandric (funnels iridescent in X and XI); gymnorchous; seminal vesicles racemose in IX and XII (XII only, Spencer). Metagynous; ovisacs present. Prostates each a broad tongue-shaped lobe, with surface lobulations, racemose in appearance but internally with single axial duct which gives off lateral branches into the gland; double vas deferens joining the middle of the long muscular external duct. Penial setae absent. Spermathecae 2 pairs, duct about as long as and clearly demarcated from the ampulla, joined near its ectal end within the body wall by a single clavate (inseminated) diverticulum; the duct entering the body wall at the lateral border of the ventral nerve cord, near the midventral line.

*Genital markings.* Constant though not always equally developed. Crater on male porophore is pyriform in specimen 4 as in specimen 1.

TYPE-LOCALITY. Table Cape. (Types in NMV, not seen.)

MATERIAL EXAMINED.

Table Cape, 145°45′E. 41°00′S. Map, 7/1, Dr J. L. Hickman, 24 Aug 1954 – specimens 1 and 2 TM: K368–369; specimen 3 BJ: T68; specimen 4 BM(NH): 1973.2.42.

### ***Oreoscolex leai*** (Michaelsen, 1910)

*Notoscolex leai* Michaelsen, 1910: 99–102, Fig. 18, 19.

l = 310 mm, w = 7 mm, s = 152.

Prostomium prolobous or possibly slightly and broadly pro-epilobous. Setae unusually delicate, in the mid- and hindbody, with the exception of the hind fourth, regularly arranged and widely paired, *aa* : *ab* : *bc* : *cd* : *dd* = 1·6 : 1 : 2 : 1 : 8. Further anteriorly, near the male pores each ventral pair is much narrowed but the lateral pair is not (in XIX *aa* ≑ 5*ab*). Clitellum midventrally insunk, though not saddle-shaped, in ½XIII–XIX. Male pores on small, almost circular papillae on XVIII in *ab*, about one-twelfth of the circumference apart. Large unpaired, midventral rounded hexagonal genital markings, extending laterally approximately to setal lines *b* and leaving only a small region of the segment between them in 15/16, 16/17, 17/18 and 18/19; the most posterior, in 18/19, only indistinct, that in 17/18 posteriorly indistinctly demarcated. Female pores indicated by a rather long, transverse furrow anteriorly in XIV. Spermathecal pores 2 pairs, in 7/8 and 8/9, those of a pair about one-tenth of the circumference apart, in line with the male pores (in setal lines *ab* ?).

Gizzard large in V; oesophagus only slightly swollen segmentally; calciferous glands absent. Intestine, at least in the first 24 segments, spiral. Dorsal vessel single. Last hearts in XII. Meronephric; a large number of nephridial tubules in each segment; in the forebody, in the region of thickened septa, nephridia less numerous and aggregated ventrally to give a spurious appearance of holonephridia. Holandric; 2 pairs of sperm funnels, in X and XI; seminal vesicles racemose in XII. Prostates slenderly tongue-shaped, long, narrow and flattened; tubuloracemose, with a central lumen extending almost the whole length of the glandular part; the mass of the glandular part composed of numerous adpressed parts with apparently epithelial ducts opening into the main duct. Vasa deferentia of a side entering the internal duct of the prostate separately at its distal fourth. Penial setae approx. 2 mm long and, almost throughout, 20 μm wide; gently and simply curved, ectally simply and slenderly pointed. Distinct ornamentation absent.

Spermathecae 2 pairs, duct short, conical, bearing a multiloculate diverticulum with 4 or 5 sperm chambers.

TYPE-LOCALITY. Tasmania, vicinity of Hobart.

MATERIAL EXAMINED.

None available.

### ***Oreoscolex longus*** sp. n.

Fig. 3, 27B, 32N, O; Plates 73–80. Table 16

l = 325, 215 mm, w = 6·0, 5·2 mm, s = 210, 231.

Prostomium epilobous ½, open. Dorsal pores indistinct; the first in 20/21. Setae 8 per segment, in regular longitudinal rows throughout. Nephropores not visible. Clitellum annular, ½XIII–XVIII, weaker ventrally in *bb* (holotype), not developed in paratype 1. Male pores at the centres of prominent transversely conjoined papillae occupying *ab* on XVIII; two long conspicuous penial setae projecting in the vicinity of each pore. Accessory genital markings: large oval paired pads in 16/17 and 19/20 extending both laterally and medianly of *ab*, a smaller pair in 9/10 in *ab*, and a median ventral pad in 20/21 (holotype); or median pads similarly extending laterally of *b* in each of intersegments 12/13–16/17 and paired markings in 19/20 and 20/21 (paratype 1). Female pores a pair anteromedian of *a*, on XIV. Spermathecal pores 2 pairs, in 7/8 and 8/9, on small papillae in *a*.

TABLE 16

Intersetal distances in segment XII in *Oreoscolex longus*

mm

| | *aa* | *ab* | *bc* | *cd* | *dd* | *dc* | *cb* | *ba* |
|---|---|---|---|---|---|---|---|---|
| paratype 1 | 1·3 | 0·6 | 1·7 | 1·2 | 4·5 | 1·3 | 1·7 | 0·5 |
| paratype 2 | 1·4 | 0·6 | 1·9 | 1·2 | 5·4 | 1·4 | 1·8 | 0·6 |
| paratype 3 | 1·9 | 0·7 | 2·1 | 1·8 | 4·5 | 1·8 | 2·1 | 0·7 |
| paratype 4 | 1·7 | 0·6 | 2·1 | 1·4 | 5·0 | 1·4 | 1·6 | 0·6 |
| paratype 5 | 1·8 | 0·6 | 2·0 | 1·3 | 5·0 | 1·3 | 1·9 | 0·6 |

standardized ($u = 100$)

| | *aa* | *ab* | *bc* | *cd* | *dd* | *dc* | *cb* | *ba* |
|---|---|---|---|---|---|---|---|---|
| paratype 1 | 10·19 | 4·41 | 13·50 | 9·37 | 34·99 | 10·19 | 13·22 | 4·13 |
| paratype 2 | 9·91 | 4·44 | 13·37 | 8·39 | 37·14 | 9·91 | 12·40 | 4·44 |
| paratype 3 | 11·87 | 4·57 | 13·70 | 11·42 | 28·77 | 11·42 | 13·70 | 4·57 |
| paratype 4 | 11·92 | 3·97 | 14·44 | 9·97 | 34·87 | 9·97 | 10·88 | 3·97 |
| paratype 5 | 12·40 | 3·95 | 13·85 | 8·93 | 34·63 | 8·93 | 13·37 | 3·95 |
| mean | 11·26 | 4·27 | 13·77 | 9·62 | 34·08 | 10·08 | 12·71 | 4·21 |
| interval/*ab* | 2·64 | 1·00 | 3·23 | 2·25 | 7·99 | 2·36 | 2·98 | 0·99 |

Last hearts in XII (latero-oesophageal; connective to dorsal vessel not recognizable). Supra-oesophageal in (?)–½XIII; well developed. Gizzard in V but septa 5/6 and 6/7 very delicate and with more posterior septa deflected far posteriorly by it; very strong and firm, fusiform with anterior rim. Extramural calciferous glands absent. Oesophagus especially vascular in XI–XIII; in IX–XIII with higher internal lamellae which are most numerous and most slender in XI and XII in which they occlude the oesophageal lumen though they do not fuse centrally. Intestinal origin XVII (holotype), or XVIII (paratype 1); a deep laminar dorsally typhlosole (at first rudimentary) beginning in XXIV. Nephridia all avesiculate: anterior nephridia indistinct; no enteronephry detected. From approximately XIV posteriorly there is a plumose median nephridium on each side which has a single preseptal funnel but which discharges exonephrically by several ducts which converge to the body wall presetally in *a*; other astomate meronephridia discharge presetally in *b*, *c* and in *d* or above *d*. Caudally there are several (> 10) preseptal funnels on each side in each segment, located in *ab*; the meronephridia being exonephric (holotype).

Holandric (funnels iridescent in X and XI); gymnorchous; seminal vesicles small, racemose, in XI and XII (holotype; not developed in paratype 1). Metagynous; ovisacs present. Prostates very tortuous, slender, lobulated tubes in XVIII–XX with narrow central lumen. Vasa deferentia of a side running together then separating before joining the muscular prostatic duct near its ental limit. Penial setae curved, moderately stout, slightly tapering ectally, the tip flattened and widened to form a blade with almost straight transverse or oblique somewhat crenulated end; ectal region, with the exception of the blade, ornamented; ornamentation consisting of numerous regularly spaced circlets of large acute spines, the circlets interrupted so that the spines are in groups, of approximately 5, slightly separated from other groups in the same circlet; some spines bifid, most simple (holotype, paratype 1, 7); length of right seta = 1·6, 2·6 mm (holotype, paratype 1); general width of shaft = 18, 25, 19 μm (holotype, paratypes 1, 7). Spermathecae 2 pairs; diverticulum (inseminated) digitiform but ectally widening greatly to form a bulbous swelling over the pore; no distinct duct developed.

Genital markings in 8 specimens of *O. longus*

| Genital markings | | Specimen | | Total number of specimens |
|---|---|---|---|---|
| Paired in | 9/10 | H | P2–7 | 7 |
| Paired (often conjoined) in | 12/13 | | P1 | 1 |
| | 13/14 | | P1 | 1 |
| | 14/15 | | P1 | 1 |
| | 15/16 | | P1 | 1 |
| | 16/17 | H | P1–3, 5–7 | 7 |
| | 19/20 | H | P1–7 | 8 |
| | 20/21 | H | P1–3, P5–6, 7 (L) | 7 |
| Median in | 21/22 | | P5 | 1 |

H = holotype; P = paratype.

MATERIAL EXAMINED.

Cox's Bight, 146°15′E. 43°30′S. Map, 18/1, Tasmanian Biological Survey, Mr C. D. King, Nov 1938 and Jun 1939 – holotype TM : K370; paratypes 1 and 5 BM(NH) : 1973.2.43–44; paratypes 2–4 TM : K371–373; paratype 6 AM : W5329; paratype 7 BJ : T69.

REMARKS. *O. longus* is identifiable by the distinctive genital field and the bulbous swelling of the spermatheca over its pore with an accompanying short, digitiform diverticulum.

### ***Oreoscolex peculiaris*** sp. n.

Fig. 3, 28B, 32M; Plates 81–82. Table 17

l = 46, 60 mm, w = 5·7, 6·0 mm, s = 146, 125.

Prostomium epilobous $\frac{1}{3}$ with suggestions of a tanylobous condition. First dorsal pore (5/6 ?), 6/7. Setae 8 per segment, *b*, *c* and *d* irregular posteriorly; *ab* narrowing and slightly nearer to the ventral midline as XVIII is approached from anteriorly or posteriorly, but absent in XVIII. Nephropores not visible, clitellum annular XIII–XVII. Male pores a pair in XVIII median to setal lines *a*, at the centre of a large oblong–oval pad-like glandular protuberance which, basally at least, includes the setal arcs (and setae *ab*) of XVII and XIX and extends laterally almost to mid *bc*, 4 circular, translucent pore-like markings present on the pad but discernible with difficulty, two at the anterior and two at the posterior limit of XVIII, with centres shortly lateral of *b* lines (holotype, paratype 1; similar in paratypes 2–5; less developed and tending to be divided in two medianly in paratypes 6–8). Female pores a pair anterior and slightly median to *a* on XIV. Spermathecal pores difficult to observe, 2 pairs of small pores in *a* at 7/8 and 8/9.

TABLE 17

Intersetal distances in segment XII in *Oreoscolex peculiaris*

mm

| | *aa* | *ab* | *bc* | *cd* | *dd* | *dc* | *cb* | *ba* |
|---|---|---|---|---|---|---|---|---|
| holotype | 1·3 | 0·4 | 3·7 | 1·0 | 3·0 | 1·1 | 3·4 | 0·4 |
| paratype 1 | 1·6 | 0·6 | 4·3 | 1·6 | 2·5 | 1·8 | 4·2 | 0·6 |
| paratype 5 | 0·8 | 0·6 | 2·1 | 1·2 | 1·9 | 1·3 | 2·1 | 0·6 |
| paratype 6 | 0·7 | 0·6 | 3·3 | 2·2 | 1·8 | 2·1 | 3·4 | 0·6 |

standardized ($u = 100$)

| | *aa* | *ab* | *bc* | *cd* | *dd* | *dc* | *cb* | *ba* |
|---|---|---|---|---|---|---|---|---|
| holotype | 8·96 | 2·99 | 25·87 | 6·97 | 20·90 | 7·96 | 23·38 | 2·99 |
| paratype 1 | 9·17 | 3·33 | 25·00 | 9·17 | 14·58 | 10·42 | 24·58 | 3·75 |
| paratype 5 | 7·48 | 5·44 | 19·72 | 11·56 | 17·68 | 12·24 | 20·40 | 5·44 |
| paratype 6 | 4·87 | 3·90 | 22·40 | 15·10 | 12·18 | 14·12 | 23·38 | 3·90 |
| mean | 7·62 | 3·92 | 23·25 | 10·70 | 16·34 | 11·19 | 22·94 | 4·02 |
| interval/*ab* | 1·94 | 1·00 | 5·93 | 2·73 | 4·17 | 2·85 | 5·85 | 1·03 |

Last hearts in XII (latero-oesophageal; connective to dorsal vessel a delicate filament). Supra-oesophageal in (?)–$\frac{1}{2}$XIV, well developed. Gizzard large and firm, with anterior rim, in V. Extramural calciferous glands absent; vascularized with high rugae in VIII–XIV, at first few; especially numerous in XII–XIV in which they form flattened papillae. Intestinal origin XVII; spiral from XX posteriorly; typhlosole absent. Nephridia (holotype): first nephridia large enteronephric (pharyngeal) tufts in V; large tufts, decreasing in size posteriorly, in VI–VIII, those in VI probably enteronephric, the others apparently exonephric. Small exonephric tufts in IX–XII. In XIII and XIV the individual tubules and ducts of the tufts have dissociated so that the meronephridia begin to spread laterally and by XV numerous discrete micromeronephridia form bands extending far laterally, the nephridia being astomate, avesiculate and exonephric; approximately 15 micromeronephridia on each side in each segment shortly behind the prostates. Abruptly, at the sixty-ninth segment, several dorsal nephridia which are dependent from the anterior septum, become enlarged and acquire, each, a preseptal funnel, giving several funnels laterally on each side in each segment; a single preseptal funnel also is present on the medianmost nephridium (holotype; caudal arrangement confirmed in paratype 3). Holandric (but incipiently metandric ?) funnels in X and XI but iridescent in XI only; gymnorchous; seminal vesicles racemose, in IX (holotype) and XII (holotype, paratype 1). Metagynous; ovisacs absent. Prostates tubuloracemose, running laterally in and restricted to XVIII; vas deferens joining the gland near its ectal end. Penial setae filiform, the tip forming a small rounded button, ornamentation absent but longitudinal furrows present; length of left seta

= 0·8 mm, general width of shaft = 12 µm (holotype). Spermathecae 2 pairs; diverticulum single, clavate, uniloculate.

MATERIAL EXAMINED.

Mt Wellington, Shoobridge Bend Track, approx. 580 m, in loam and clay in eucalypt – fern woodland, 147°15′E. 42°55′S. Map, 14/4, Dr B. G. M. Jamieson and Mr E. A. Bradbury, 19 Aug 1971 – holotype TM : K374; paratypes 1 and 3 BM(NH) : 1973.2.45–46; paratypes 2, 6 and 7 TM : K375–377; paratype 4 AM : W5330; paratype 5 BJ : T70.

REMARKS. Location of the male pores median to setal lines *a* on a midventral, pad-like glandular protuberance which bears pore-like genital markings, diagnoses this species. The specific name refers to the restriction of multiple caudal nephrostomes to a dorsal situation distinct from the ventral funnel. Other peculiarities are indicated in the generic definition.

## ***Oreoscolex sexthecatus*** sp. n.

Fig. 3, 29A, 32P, Q; Plates 83–86. Table 18

l ? (posterior amputee), w = 6·3 mm, s ? (holotype).

Prostomium epilobous $\frac{5}{6}$. First dorsal pore 5/6. Setae 8 per segment; *b*, *c* and *d* irregular posteriorly. Nephropores not visible. Clitellum not developed. Male pores in *b* on ovoid papillae which extend from *a* lateral of *b*. Paired eye-like genital markings with centres in *b*, radius *ab* or less, in 13/14, 14/15, 15/16, 16/17 and 19/20. Female pores paired on small papillae anterior and slightly median of *a* on XIV. Spermathecal pores 3 pairs, in 6/7–8/9, in *b* lines.

TABLE 18

Intersetal distances in segment XII in *Oreoscolex sexthecatus*

| | mm | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | *aa* | *ab* | *bc* | *cd* | *dd* | *dc* | *cb* | *ba* |
| holotype | 1·6 | 0·6 | 1·8 | 1·7 | 6·3 | 1·9 | 1·8 | 0·6 |
| | standardized (*u* = 100) | | | | | | | |
| | *aa* | *ab* | *bc* | *cd* | *dd* | *dc* | *cb* | *ba* |
| holotype | 9·73 | 3·54 | 11·06 | 10·62 | 38·94 | 11·50 | 11·06 | 3·54 |
| interval/*ab* | 2·75 | 1·00 | 3·12 | 3·00 | 11·00 | 3·25 | 3·12 | 1·00 |

Last hearts in XII (latero-oesophageal, with filamentous connective to dorsal vessel). Supra-oesophageal in $\frac{1}{2}$VIII–$\frac{1}{2}$XIII, well developed. Gizzard large and firm, in V; preceded in IV by a large, thin-walled proventriculus. Extramural calciferous glands absent. Oesophagus vascular in VII–XVI, with internal rugae, though these are poorly developed in VII–IX and nowhere form lamellae, their greatest development, as flattened papillae, being in XIV. Intestinal origin XVII (? macerated); typhlosole ? Nephridia: astomate, avesiculate, exonephric meronephridia in II to the amputation at about XXV; very slender ducts entering the

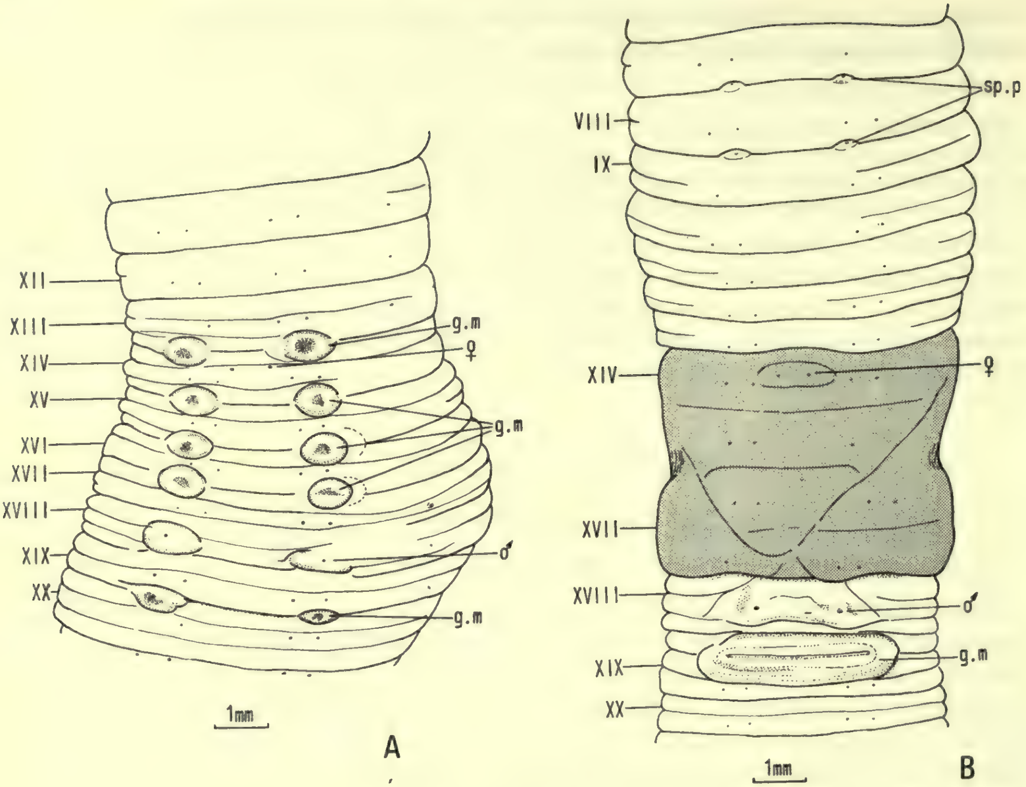


FIG. 29. Genital fields. A, *Oreoscolex sexthecatus*, holotype. B, *O. wellingtonensis*, 14/5, specimen 1.

body wall in front of setal follicles *a*, *b*, *c* and *d* and near middorsal : the *a* and *b* and, anteriorly, the *c* and *d* nephridia forming spiral-looped aggregations with the appearance of tufts, but presetal ducts remaining separate. A posterior fragment which corresponds in appearance with the posterior amputee (there being only one other, very small, worm in the sample) has 5 preseptal funnels on each side in caudal segments, the nephridia remaining exonephric. Holandric (funnels and free sperm masses but no iridescence observed) ; gymnorchous ; very large racemose seminal vesicles in IX and XII. Metagynous ; ovisacs in XIV. Prostates racemose, curved linear, extending through several segments, the surface deeply lobulated ; the central lumen moderately wide with many side branches. Penial setae almost straight, moderately slender, scarcely tapering ectally except at the tip which is obtuse and rounded (worn ?) ; the region behind the tip furrowed ; the shaft further entally bearing numerous scattered groups of small but attenuated spines which are often bifid or trifid ; length = 1·5 mm, general width of shaft = 18 μm. Spermathecae 3 pairs of unusual form : duct greatly expanded with a correspondingly enlarged internal lumen, joined by a bilobed or multiloculate diverticulum ; the sac-like ampulla with one or two variably developed ectal outpouchings.

MATERIAL EXAMINED.

Lake St Clair, 146°10′E. 42°05′S. Map, 13/5, Tasmanian Biological Survey: J19, Mr R. W. Kerr, Feb 1941 – holotype TM: K378.

REMARKS. The combination of several pairs of intersegmental genital markings, 3 pairs of spermathecal pores and ectal outpouchings of the spermathecal ampulla distinct from spermathecal diverticula, diagnoses this species.

### ***Oreoscolex wellingtonensis*** (Spencer, 1895)

Fig. 3, 29B, 32R; Plates 87–90. Table 19

*Cryptodrilus wellingtonensis* Spencer, 1895: 43–44, Pl. 3, fig. 25–27.
*Notoscolex wellingtonensis*; Michaelsen, 1900: 192–193; Jamieson, 1971c: 79.

l = 140, 155 mm, w = 5·8, 5·5 mm, s = 138, 149 (specimens 1 and 3).

Prostomium epilobous ½, closed. First dorsal pore 4/5, 3/4; pores very conspicuous in the mid- and hind-body. Setae 8 per segment in regular longitudinal rows; *d* occasionally absent. Nephropores not visible. Clitellum annular, XIV–XVII. Male pores on XVIII in *a* on a large glandular pad which extends laterally beyond *b* and fills the segment longitudinally (specimen 1), this pad replaced in specimens 3–5 by two large oval papillae, each bearing a male pore. A large median oblong-oval glandular pad in 19/20 (specimens 1, 2) or 20/21 (specimens 3, 4) extends laterally beyond *b*, includes the setal annulus of the preceding segment and reaches that of the succeeding segment and is traversed by a groove corresponding with the intersegment. A similar pad present in 12/13 in specimen 3 and a suggestion of a small midventral pad median to *a* in 17/18 in specimens 1–3. Female pores paired, median to and only slightly anterior to *a*, at about ⅓*aa*, on XIV. Spermathecal pores 2 pairs on small papillae, or concealed, in 7/8 and 8/9, in *a* lines.

TABLE 19

Intersetal distances in segment XII in *Oreoscolex wellingtonensis*

mm

| | *aa* | *ab* | *bc* | *cd* | *dd* | *dc* | *cb* | *ba* |
|---|---|---|---|---|---|---|---|---|
| specimen 2 | 1·6 | 0·5 | 1·4 | 1·3 | 8·9 | 1·1 | 1·4 | 0·5 |
| specimen 3 | 1·3 | 0·5 | 2·1 | 2·6 | 4·1 | 2·6 | 2·3 | 0·5 |
| specimen 4 | 2·0 | 0·6 | 1·8 | 1·5 | 8·2 | 1·5 | 1·8 | 0·6 |

standardized ($u$ = 100)

| | *aa* | *ab* | *bc* | *cd* | *dd* | *dc* | *cb* | *ba* |
|---|---|---|---|---|---|---|---|---|
| specimen 2 | 9·79 | 2·98 | 8·51 | 7·66 | 52·77 | 6·81 | 8·51 | 2·98 |
| specimen 3 | 7·96 | 3·10 | 13·27 | 16·37 | 25·66 | 16·37 | 14·16 | 3·10 |
| specimen 4 | 11·16 | 3·19 | 9·96 | 8·37 | 45·82 | 8·37 | 9·96 | 3·19 |
| mean | 9·64 | 3·09 | 10·58 | 10·80 | 41·42 | 10·52 | 10·88 | 3·09 |
| interval/*ab* | 3·12 | 1·00 | 3·42 | 3·50 | 13·40 | 3·40 | 3·52 | 1·00 |

Last hearts in XII (latero-oesophageal). Supra-oesophageal moderately developed, ending at ½XIII. Gizzard large, firm in V extending posteriorly to the level of XI, oesophagus virtually suppressed to this segment ; in XII–XIV with high vascular internal rugae, intestinal origin XVI, deep dorsal typhlosole commencing in XXIV (specimens 1 and 3). Nephridia : pairs of very large tufted nephridia in II–V with composite ducts ; those of II apparently opening into the buccal cavity ; those of III and IV and possibly V running forward to open ventrolaterally at the mouth. Nephridia in VI–IX forming smaller tufts exonephric in each segment. By XII there are dense lateral bands of meronephridia ; those of segments X and XI being intermediate between tufts and these lateral bands. Caudally with very numerous exonephric (?) micromeronephridia on each side, each nephridium with a minute preseptal funnel (specimen 1). Holandric (funnels iridescent in X and XI) ; gymnorchous ; seminal vesicles racemose, in IX and XII. Prostates linear but externally racemose, extending laterally in, and restricted to, XVIII ; narrow central lumen present with few side branches. Penial setae moderately slender, sinuous, the tip flattened and widened to form a blade which is terminally straight edged with a few irregular teeth ; ectal region, with the exception ot the blade, with a feathered appearance produced by a series of numerous composite spines, each of which is approximately triangular but has several long and often branched lateral pinnae ; length of left seta = 1·1 mm ; general width of shaft = 18 $\mu$m (specimen 1). Metagynous ; ovisacs absent. Spermathecae 2 pairs ; diverticulum (inseminated) sessile, multiloculate.

TYPE-LOCALITY. Mount Wellington. Map, 14/4.

MATERIAL EXAMINED.

Domain, Hobart, 147°20′E. 42°50′S. Map, 14/5, Dr J. L. Hickman, 14 Aug 1954 – specimen 1 TM : K379, 7 Nov 1955 – specimen 2 AM : W5331. Kelly's Basin, Port Davey, 145°55′E. 43°20′S. Map, 17/1, Tasmanian Biological Survey : Mr C. D. King, Jan 1940 – specimen 3 BM(NH) : 1973.2.47. 'Tasmania', Dr J. L. Hickman – specimen 4 BJ : T71.

REMARKS. The new material conforms sufficiently well with Spencer's account for there to be little doubt of conspecificity. The fact that one of the new specimens is almost topotypic and that no form more closely resembling Spencer's description was found further supports the identification. Differences in Spencer's account are slight, *viz.* length $<$ 100 mm ; prostomium only slightly epilobous ; male and spermathecal pores in *ab* ; clitellum extending slightly onto the dorsal surface of XVIII. Accessory genital markings are said by Spencer to be swollen tumid ridges on XVIII, XIX and XX, marked differences from the present specimens, but his illustration (Plate 3, fig. 25) shows a single intersegmental marking only, in 19/20, as described in this account.

## Genus ***MEGASCOLEX*** Templeton, 1844

DIAGNOSIS. Setae, at least in the mid- and hindbody numerous (more than 8) per segment. Prostates 1 pair, racemose, their pores on XVIII or, exceptionally, an adjacent segment ; sometimes associated with penial setae. Female pores paired or exceptionally unpaired. Spermathecal pores usually 1–5 pairs between IV and IX (the exceptions are the few cases where the pores are fused in the midline, or where they are numerous on each side in each segment occupied). One gizzard, in V, VI or VII. Calciferous glands present or absent. Meronephric, with or without enteronephric nephridia. Holandric, rarely metandric; testis-sacs present or absent. Ovaries in XIII. Spermathecae with or without free diverticula.

TYPE-SPECIES. *Megascolex caeruleus* Templeton, 1844 (Ceylon).

DISTRIBUTION. Ceylon and India. Australia, with Tasmania. New Caledonia. New Zealand. Norfolk Island. Annam.

### *Tasmanian species*

*M. burniensis* sp. n.
*M. montisarthuri* sp. n.
*M. tasmanicus* (Spencer, 1895).

### *Other species*

Sixty-five Australian species, in addition to the Tasmanian complement, are listed in Jamieson, 1971c (*q.v.*). This is a very large genus with many species in extra-Australian parts of its range.

REMARKS. *Megascolex* is a polyphyletic congeries in need of revision and constitutes one of the major problems in oligochaete taxonomy (Jamieson, 1971c). It is the type-genus of the tribe Megascolecini, purely meronephric megascolecines in which, if there is a median stomate nephridium, this opens into the intestine.

The following three Tasmanian species are provisionally retained in *Megascolex*, with the definition of which they conform, pending revision of the genus. Sufficient grounds exist to suggest that the Tasmanian species comprise one or more separate genera but erection of the latter is deferred until the mainland species of *Megascolex* are revised.

### KEY TO TASMANIAN SPECIES OF *MEGASCOLEX*

| | | |
|---|---|---|
| 1 | Spermathecal pores 2 pairs . . . . . . . . . . . . | 2 |
| – | Spermathecal pores 5 pairs. Fig. 30C . . . . | **M. tasmanicus** (Spencer, 1895) |
| 2 | Spermathecal pores median to *a*, almost contiguous ventrally. Fig. 30A | **M. montisarthuri** sp. n. |
| – | Spermathecal pores in *ab*. Fig. 30B . . . . . . . | **M. burniensis** sp. n. |

## ***Megascolex burniensis*** sp. n.

Fig. 4, 30B, 32F

l = 65 mm, w = 4·0 mm, s = 92.

Prostomium tanylobous. First dorsal pore 4/5. Setae 12 on XII; 24 caudally (30 counted in some segments); seta become irregular in the posterior 25 segments; $zz \doteqdot zy$ anteriorly but $zz \doteqdot 2\text{–}4zy$ posteriorly; $aa \doteqdot 2\text{–}2{\cdot}5ab$ preclitellar, $aa \doteqdot 3\text{–}4ab$ postclitellar; *aa* not discernible as a ventral break caudally. Nephropores not externally visible. Clitellum annular $\frac{1}{2}$XIII–XVII. Male pores on small papillae in *ab*, nearer *a*, on XVIII. Genital markings: 3 pairs of small eye-like markings

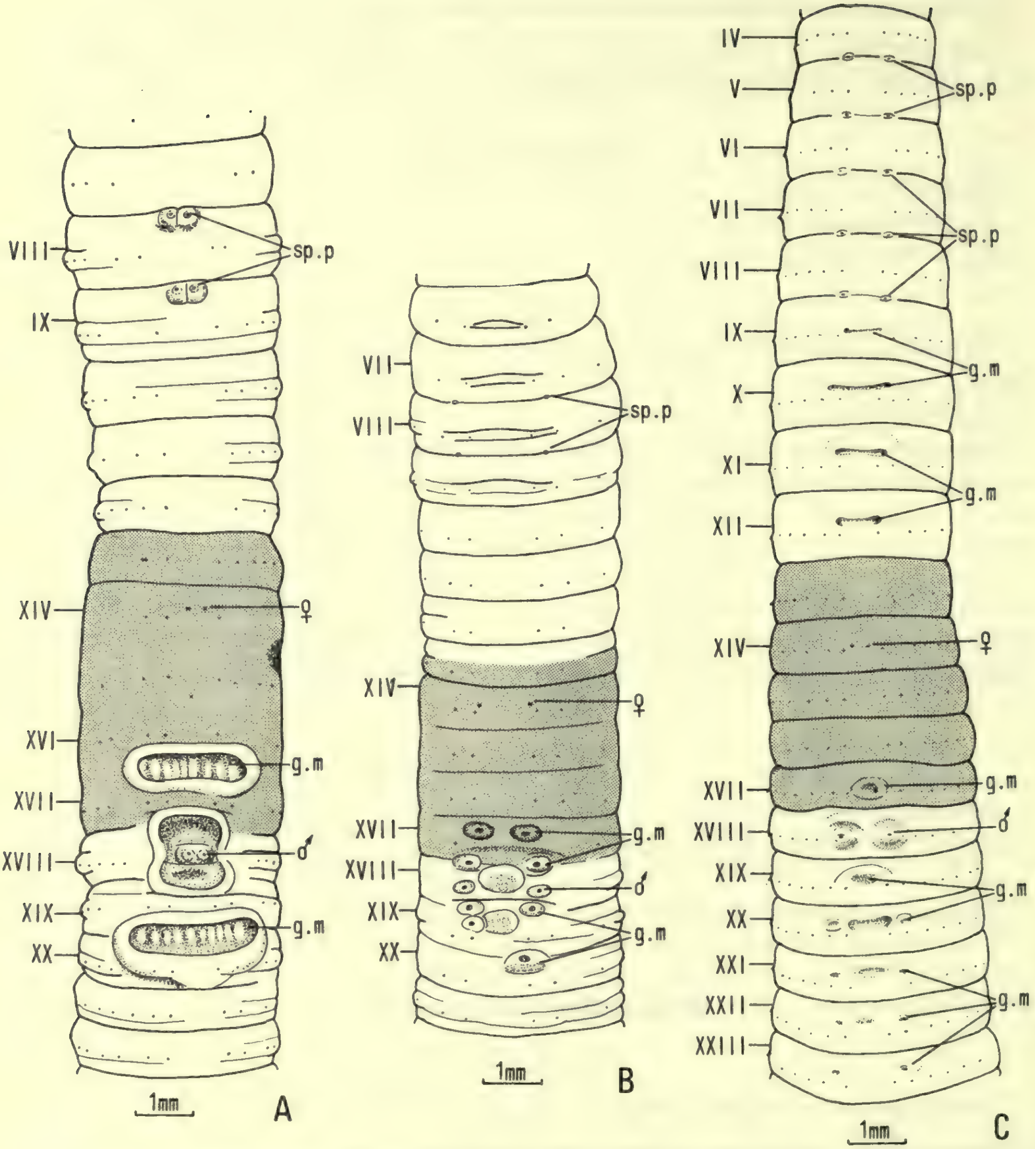

VIII
sp.p
IX
XIV
♀
XVI
g.m
XVII
XVIII
♂
XIX
g.m
XX
1mm
A
VII
VIII
sp.p
XIV
♀
XVII
g.m
XVIII
♂
XIX
g.m
XX
1mm
B
IV
V
sp.p
VI
VII
sp.p
VIII
IX
g.m
X
XI
g.m
XII
XIV
♀
XVII
g.m
XVIII
♂
XIX
g.m
XX
XXI
g.m
XXII
XXIII
1mm
C

FIG. 30. Genital fields. A, *Megascolex montisarthuri*, holotype. B, *M. burniensis*, holotype. C, *M. tasmanicus*, specimen 1.

with centres approximately in *a*, one pair presetal in XVII, the other two pairs in 17/18 and 18/19; two similar presetal unpaired markings with centres in *a* in XIX (right) and 19/20 (left); two larger median presetal markings present in XVIII and XIX. Female pores paired, anterior and slightly median to *a* of XIV. Spermathecal pores 2 pairs, in 7/8 and 8/9, on small papillae slightly lateral of *a*.

Last hearts in XIII (hearts in X–XIII latero-oesophageal with connective to dorsal and supra-oesophageal vessel); supra-oesophageal in VII–XIII, well developed. Gizzard large, firm, globular with anterior rim, in V. Extramural calciferous glands absent; oesophagus with circumferential vascular striae in VIII–XV; rugae increasing posteriorly, especially well developed in XIV and XV. Intestinal origin XVII; typhlosole absent. Nephridia poorly preserved; few avesiculate, exonephric meronephridia on each side in each segment; exonephric tufts in II–VII; caudally exonephric with a preseptal funnel on each side, the median nephridium somewhat enlarged. Holandric (funnels iridescent in X and XI); gymnorchous; seminal vesicles racemose in XI and XII. Metagynous; ovisacs present? (a small, flocculent mass, on the right side only, is doubtfully an ovisac). Prostates flattened and almost square, in XVII and XVIII; truly racemose, the muscular duct dividing into three immediately within the gland; vas deferens joining the duct near its ental end. Penial setae absent. Spermathecae 2 pairs, in VIII and IX, diverticulum (inseminated) single, clavate, uniloculate.

MATERIAL EXAMINED.

Fern Glade, Emu River, Burnie, 145°55′E. 41°05′S. Map, 7/2, Dr J. L. Hickman, 24 Aug 1954 – holotype TM: K380.

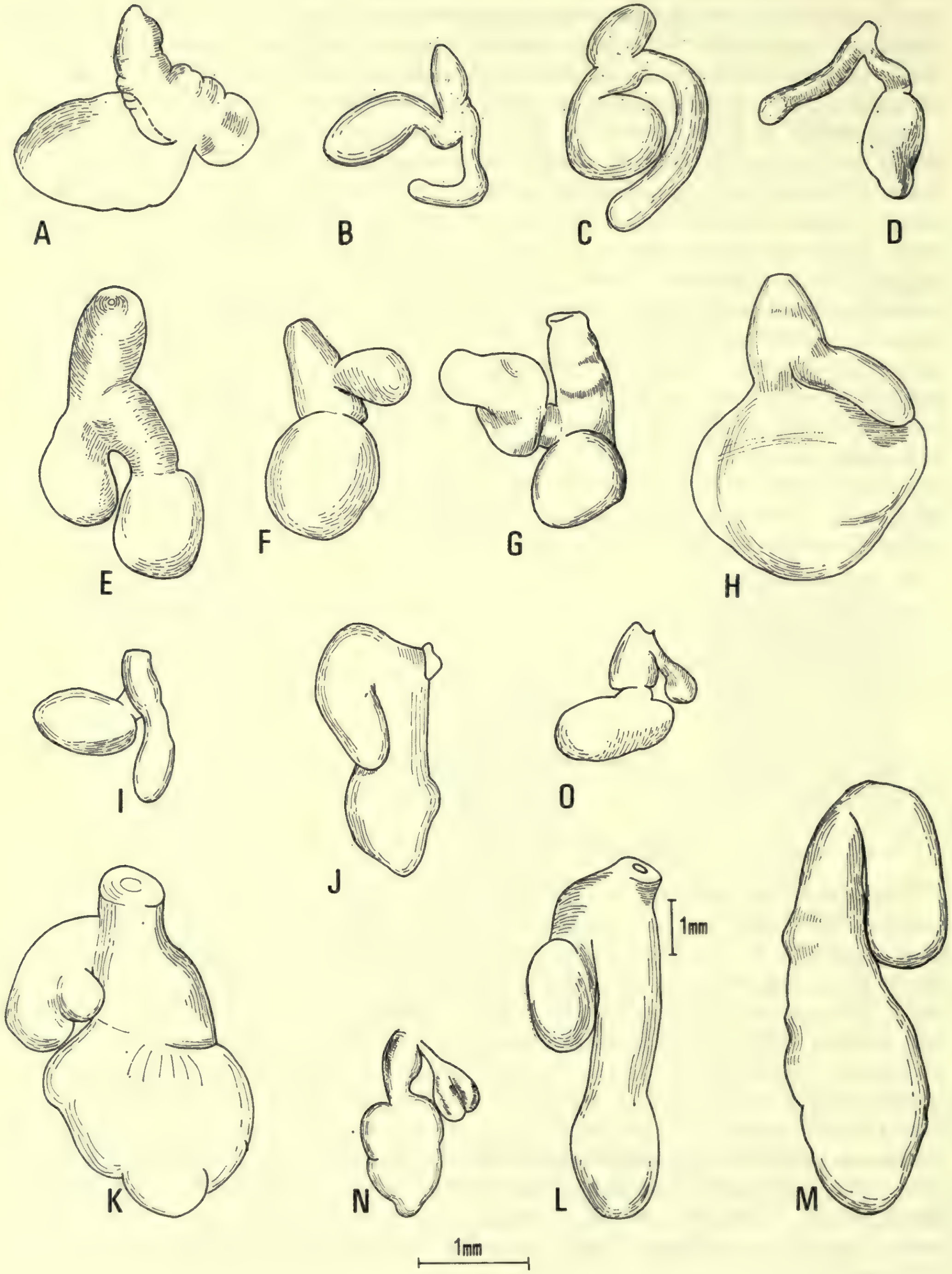
REMARKS. The genital field is diagnostic of this species.

## ***Megascolex montisarthuri*** sp. n.

Fig. 4, 30A, 32G

l = 95, 105 mm, s = 3·6, 5·2 mm, s = 125, 123.

Prostomium canaliculate or not, tanylobous closed. First dorsal pore 3/4, 4/5. Setae 18 (holotype), 12 (paratype 1) in XII, caudally with 24 or more in a segment; rows regular in the fore- and midbody, with the ventral gap ≑ 3*ab* and much wider dorsal gap; caudally with *aa* unchanged but other rows irregular and no appreciable dorsal interruption of the setal circlet. Nephropores not externally visible. Clitellum annular, XIII–XVII (holotype, paratype 1) with weak development in XVIII (holotype). Male pores almost contiguous midventrally in XVIII on a pair of united papillae which lie in a depression with tumid borders which extends almost from the setal arc of XVII to that of XIX and laterally reaches *b* lines; a midventral transverse glandular depression with tumid margins present in each of intersegments 9/10, 16/17 and 19/20, spanning *cc* and carrying a transverse series of whitish pore-like stigmata. Female pores anteromedian to setae *a* at about $\frac{1}{3}$*aa*. Spermathecal pores 2 pairs, on medianly closely apposed papillae near the anterior margins of VIII and IX.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Dorsal vessel single ; continuous onto the pharynx ; last hearts in XII (hearts in X–XII latero-oesophageal, with connective to dorsal and supra-oesophageal vessel) ; supra-oesophageal weakly developed ; gizzard very well developed, in V but extending posteriorly into IX by displacement of attenuated septa ; oesophagus widened to form an annular calciferous gland with numerous high radial internal lamellae in XV (holotype, paratypes, 1, 8) ; similarly developed in XVI and not demarcated from that in XV in holotype, or in XIV and less so in XIII in paratype 1 ; swollen and vascular, almost reniform on each side in XVII in paratypes 1 and 8. Intestinal origin XVIII reaching full width in XIX ; typhlosole strongly developed ; first appreciable (rudimentary) in XX–XXI (holotype, paratypes 1, 8). Nephridia several exonephric, astomate, avesiculate parietal meronephridia on each side in each segment ; a large pair of tufts in III, extending into II and IV and each sending a sheaf of ducts (composite duct) to enter the parietes anterior to seta *b* of II ; caudally the medianmost nephridium enlarged as a megameronephridium with single preseptal funnel (exonephric) (holotype). Holandric (funnels iridescent) ; gymnorchous ; seminal vesicles racemose, in XI (small) and XII ; metagynous ; small ovisacs in XIV ; prostates compact, racemose, restricted to XVIII (holotype, paratypes 1, 8) with ramifying internal ducts and no dominant central duct ; vas deferens joining ectal end of duct (holotype). Penial setae absent. Spermathecae 2 pairs, in VIII and IX (the ampullae in the segment anterior to its pores in the holotype only) ; diverticulum (inseminated) small, clavate, uniloculate (holotype ; paratypes 1, 8).

MATERIAL EXAMINED.

Mt Arthur, Weldborough Pass, 1·6 miles from eastern end, 147°55′E. 41°10′S. Map, 9/3, Dr J. L. Hickman, 26 Aug 1953 – holotype TM : K381. East side of mountain 147°20′E. 41°15′S. Map, 9/1, Mr A. J. Dartnall and Mr R. C. Kershaw, 15 Oct 1971 – paratypes 1, 8, 16–18 BM(NH) : 1973.2.48–52 ; paratypes 2–7, 9–15 TM : K382–394 ; paratypes 19–25 AM : W5332–5338 ; paratypes 26–29 BJ : T72–75.

REMARKS. The closely apposed spermathecal and male pores and the very distinctive accessory genital markings permit ready identification of *M. montisarthuri* and jointly distinguish it from all other species.

Of 29 paratypes from Mt Arthur, all agree with the holotype in possessing the characteristic median transverse genital markings at 16/17 and 19/20, the median field around the two male pores being variably developed ; 25 of these have an additional transversely punctate genital marking extending laterally into *ab* in 9/10.

FIG. 31. Spermathecae of *Cryptodrilus*. A, *C. avesiculatus*, holotype (right IX). B & C, *C. brunyensis* : B, holotype (right VIII) ; C, paratype (right IX). D, *C. dartnalli*, holotype (left IX). E–G, *C. enteronephricus* : E, holotype (right IX) ; F, paratype 3 (right IX) ; G, paratype 14 (right IX). H, *C. polynephricus polynephricus*, specimen 12 (right IX). I, *C. polynephricus* ad *urethrae*, specimen 44 (right IX). J–M, *C. p. urethrae* : J, holotype (right VIII) ; K, paratype 1 (right IX) ; L, paratype 8 (right IX) ; M, paratype 20 (right IX). N & O, *C. simsoni* : N, lectotype (right VIII) ; O, specimen 2 (right IX). All except L to the scale indicated.

### ***Megascolex tasmanicus*** (Spencer, 1895)

Fig. 4, 30C, 32H, I

*Perichaeta tasmanica* Spencer, 1895 : 47–48, Pl. IV, fig. 37–39.
*Megascolex tasmanicus* ; Michaelsen, 1900 : 217 ; Jamieson, 1971c : 96.

l = 70, 75 mm (63–88 mm, Spencer), w = 3·5 mm (3·1 mm, Spencer), s = 89, 93 (specimens 1 and 2).

Prostomium epilobous ⅔ (⅓–½, Spencer), open ; peristomium bifid ventrally. First dorsal pore 4/5. Setae 18 (specimen 1), 25 (specimen 2) (20–22, Spencer) in XII ; 28–30 caudally (24–28, Spencer) ; *zz* ≑ 2*zy* anteriorly, irregular caudally, forming a definite gap in the setal circlet in the fore- and midbody but inappreciable at the caudal extremity ; *aa* ≑ 2*ab* anteriorly, regular throughout, ≑ 3*ab* caudally, a definite gap throughout ; setae *a* and *b* absent in XVIII. Nephropores not externally visible. Clitellum weakly developed, annular, in XIII–XVII (as Spencer). Male pores small but conspicuous transverse slits in *a* or *ab*, on XVIII, each on the suggestion of a small papilla, in a circular, glandular, depressed field. Accessory genital markings incompletely developed but well-defined, presetal median transverse glandular bands in IX, X, XI, and XII extending maximally to *ab* (specimen 1) or rudimentary in VIII–XI (specimen 2) ; a presetal, median, approximately oval, depressed glandular patch in each of segments XVII–XXII ; similar but paired circular presetal markings present in each of segments XX–XXIII, almost contiguous with the median marking where one occurs in the same segment (markings median in IX, X, XI, XX, XXI and XXII, Spencer). Female pores a pair in XIV, shortly anterior to the setal arc and close together at about ½*aa* ; spermathecal pores 5 pairs of small but distinct white-rimmed slits, in 4/5–8/9, in *a* lines.

Internal anatomy (specimen 1) : dorsal blood vessel single, continuous onto the pharynx ; last hearts in XII (hearts in X–XII latero-oesophageal, each with connective to dorsal and supra-oesophageal vessel) ; supra-oesophageal in IX–½XIII, well developed. Gizzard muscular, but small and easily compressed, in V ; true ovoidal calciferous glands, 3 pairs in segments X, XI and XII, each sessile, with a narrow connection with the lateral wall of the oesophagus, the lumen of the gland almost occluded by approximately 12 laminae which converge on the connection with the oesophagus but do not unite ; intestinal origin XV (XVIII, Spencer) ; a very low but definite typhlosole present, first appreciable, though very rudimentary,

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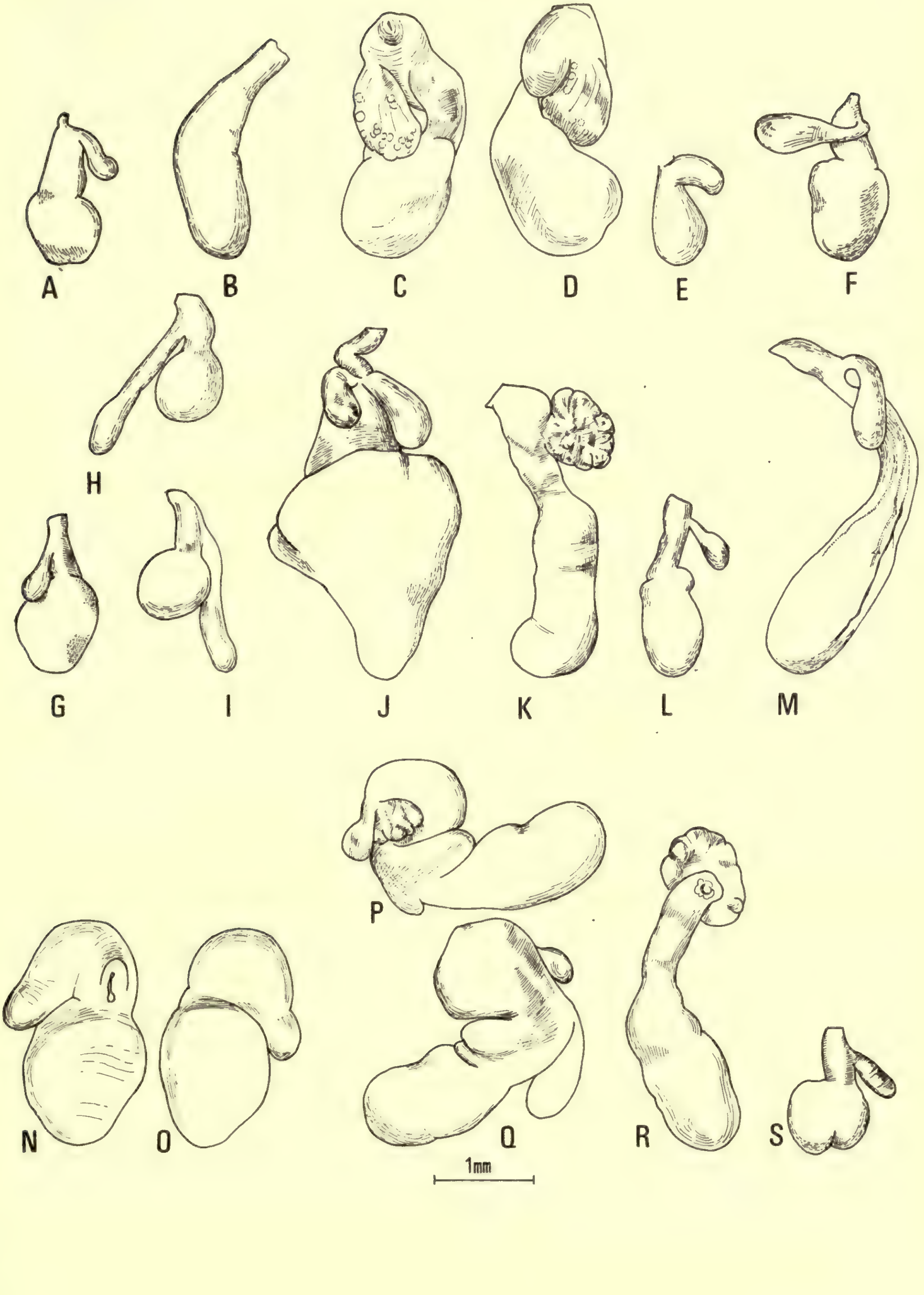
FIG. 32. Spermathecae. A, *Graliophilus tripapillatus*, holotype (right IX). B, *Pinguidrilus tasmanicus*, lectotype (right IX). C & D, *Hickmaniella opisthogaster*, holotype : C, ventral view ; D, dorsal view (right IX). E, *Rhododrilus littoralis*, holotype (right IX). F, *Megascolex burniensis*, holotype (right IX). G, *M. montisarthuri*, holotype (right IX). H & I, *M. tasmanicus*, specimen 1 : H, left IX ; I, right VIII. J, *Oreoscolex bidiverticulatus*, holotype (right IX). K, *O. campestris*, specimen 1 (right IX). L, *O. irregularis*, specimen 1 (right VIII). M, *O. peculiaris*, holotype (right IX). N & O, *O. longus*, holotype : N, dorsal view ; O, ventral view (right IX). P & Q, *O. sexthecatus*, holotype : P, ventral view ; Q, dorsal view (right VIII). R, *O. wellingtonensis*, specimen 1 (right IX). S, *Pseudocryptodrilus acanthodriloides*, holotype (right IX). All to the same scale excepting E which is twice the scale indicated.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in XVI; caeca and muscular thickening absent. A few small exonephric tufted nephridia on each side in IV, small nephridia apparently present in III (and II ?); astomate, avesiculate, exonephric micromeronephridia numerous on each side, forming a dense parietal band, in XV posteriorly; less numerous in V–XIV. Caudally with numerous micromeronephridia and a median nephridium which has several spiral loops and might be considered a megameronephridium. The median nephridium with a large preseptal funnel and with its duct joining a paired duct running longitudinally on the roof of the intestine shortly lateral of the dorsal blood vessel; this longitudinal duct connected to and presumably opening into the intestine posteriorly in each segment. Caudal micromeronephridia associated with preseptal bodies which may be reduced funnels; whether enteronephric or exonephric not determined. Holandric (funnels iridescent in X and XI); gymnorchous; seminal vesicles racemose, very large, in IX and XII, the larger in IX. Metagynous; ovisacs present. Prostates racemose, bipartite, one lobe in XVIII, the other in XIX, the muscular duct bifurcating immediately within the gland, joined entally by the vas deferens. Penial setae absent. Spermathecae 5 pairs, diverticulum single, longer than the ampulla, clavate, uniloculate.

TYPE-LOCALITY. Emu Bay, Tasmania, and King Island in Bass Strait. Map, 7/2.

MATERIAL EXAMINED.

Table Cape, 145°45′E. 41°00′S. Map, 7/1, Dr J. L. Hickman, 24 Aug 1954 – specimen 1 TM: K395; specimen 2 BJ: T76.

REMARKS. *M. tasmanicus* is questionably distinct from the Victorian species *M. hoggi* (Spencer 1892b) and its occurrence on King Island may indicate that it represents a Tasmanian population of the latter species. If so, it would constitute the only known case of a megascolecid species shared between Tasmania and the mainland. Spencer (1895) drew attention to the similarity of *M. tasmanicus*, *M. sylvaticus*, *M. hoggi*, *M. halli*, *M. rubra*, *M. frenchi* and *M. steeli*, all Victorian species of Spencer (1892b), in having a bifid peristomium, 5 pairs of spermathecal pores, calciferous glands in X–XII and bilobed prostates. This combination of characters suggests a basis for recognition of a new (wholly dichogastrin ?) genus distinct from *Megascolex*.

## ACKNOWLEDGEMENTS

The author is deeply indebted to Dr J. L. Hickman of the University of Tasmania for providing his incomparable collections and to Mr R. W. Sims for providing facilities in the British Museum (Natural History) for this study. Thanks are also due to other collectors, acknowledged in the text, and to Miss E. Pope, Dr P. Hutchings, Mr A. J. Dartnall and Dr B. J. Smith of the Australian, Tasmanian and National Museums for loan of material. Mr E. A. Bradbury, Mr T. Walker and Mr J. Casey are thanked for their assistance and Miss O. Page-Hanify for her efficient typing. Mr Walker took the photographs in cooperation with the Electron Microscope Centre, University of Queensland, and also prepared the maps. All line drawings are by the author. The work was made possible by Australian Research Grants Committee grant nos. 239260-300-R-Zool-ARGC-120-71-72.

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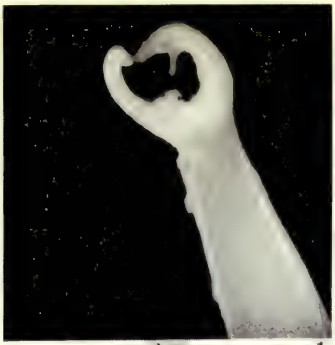
## PLATES 1-12

Scanning electron micrographs of penial setae. 1, *Graliophilus tripapillatus*, holotype.
2 & 3, *Cryptodrilus avesiculatus*, holotype.
4-7, *C. brunyensis* : 4-6, one seta ; 7, a second seta of paratype 1.
8-12, *C. dartnalli* : 8-10, paratype 8 ; 11 & 12, holotype.



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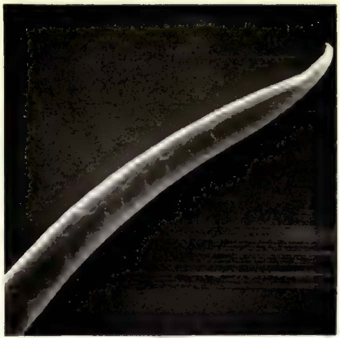

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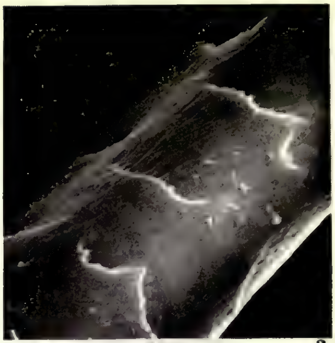

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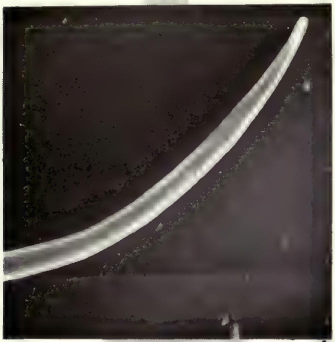

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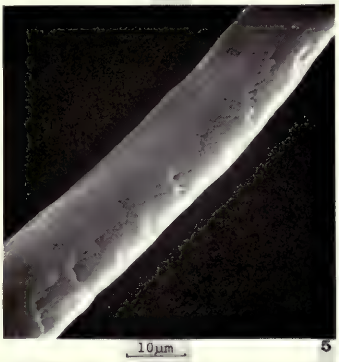

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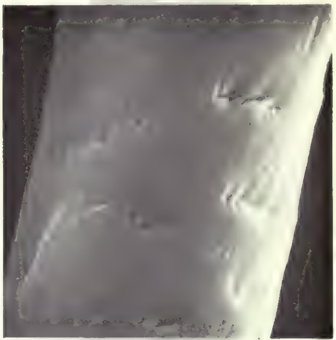

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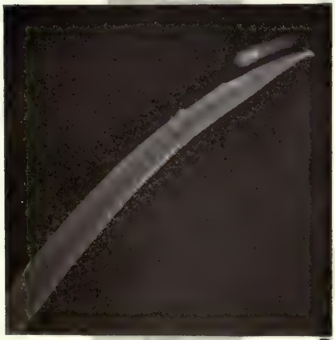

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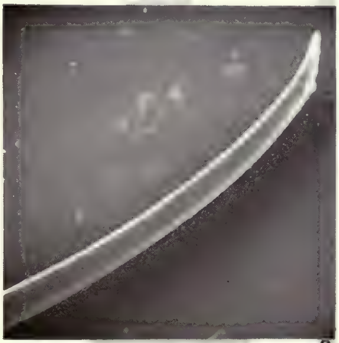

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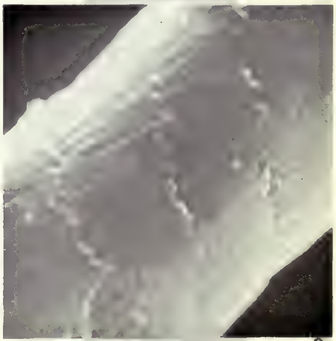

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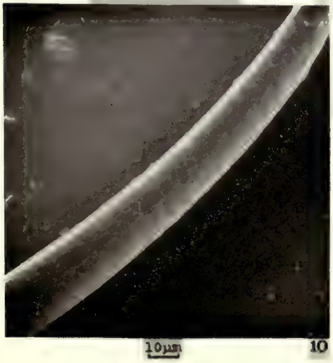

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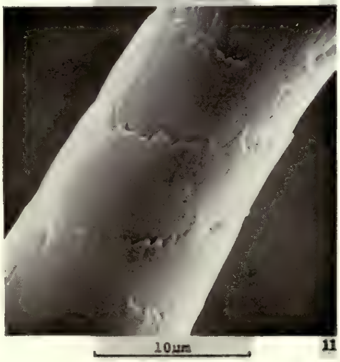

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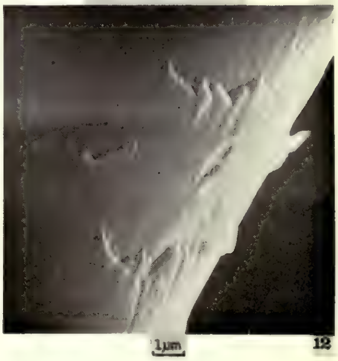
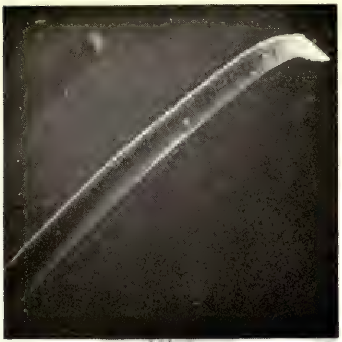


12

## PLATES 13–24

Scanning electron micrographs of penial setae. 13–19, *Cryptodrilus enteronephricus*: 13–15, paratype 1; 16–19, paratype 14.

20–24, *C. polynephricus polynephricus*: 20 & 21, specimen 3; 22, specimen 1; 23 & 24, specimen 5.



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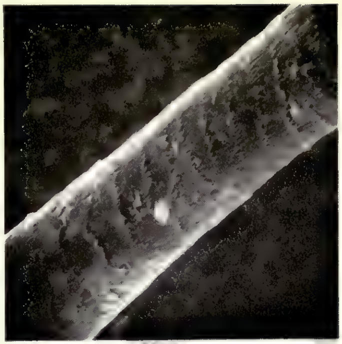

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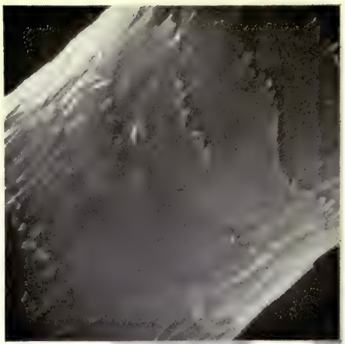

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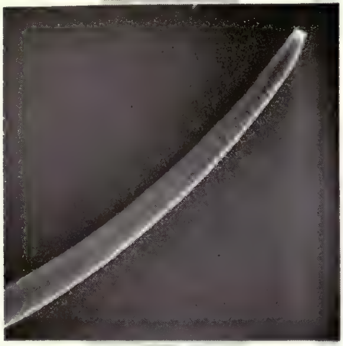

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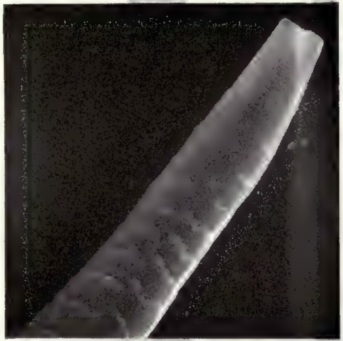

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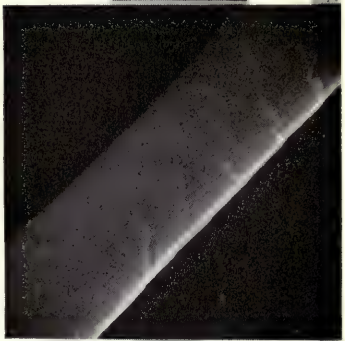

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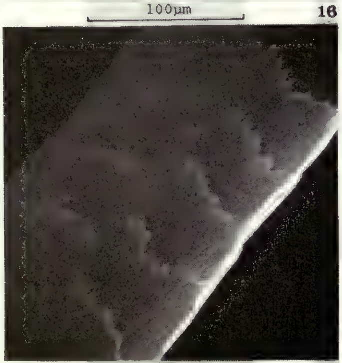

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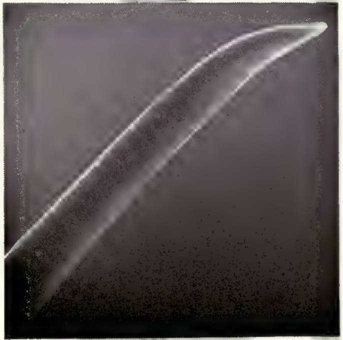

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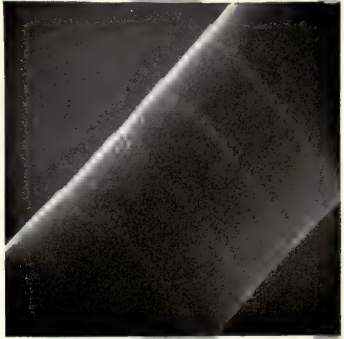

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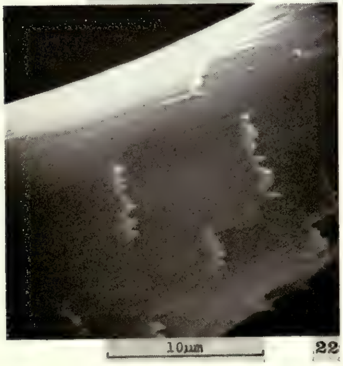

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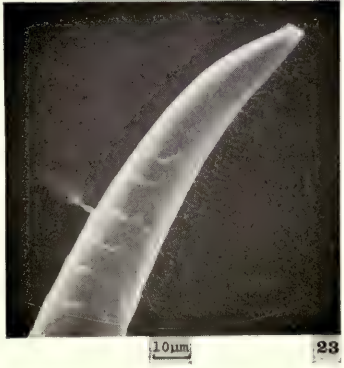

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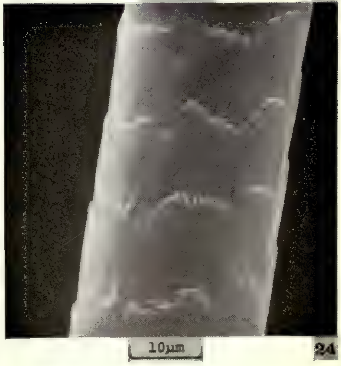
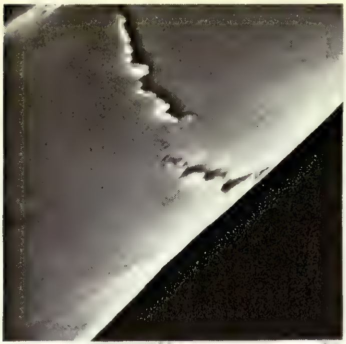


24

## PLATES 25–36

Scanning electron micrographs of penial setae. 25–31, *Cryptodrilus polynephricus polynephricus* : 25, specimen 10 ; 26, specimen 8 ; 27 & 28, specimen 24 ; 29–31, specimen 34. 32–36, *C. p. polynephricus* ad *urethrae* : 32 & 33, specimen 42 ; 34–36, specimen 44.



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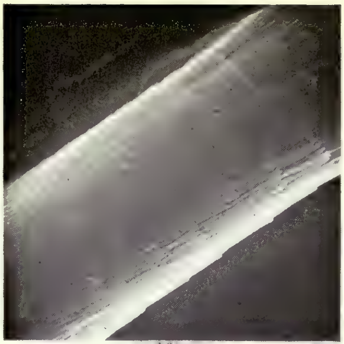

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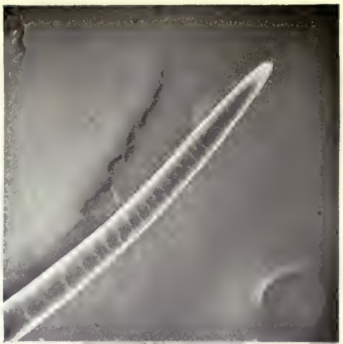

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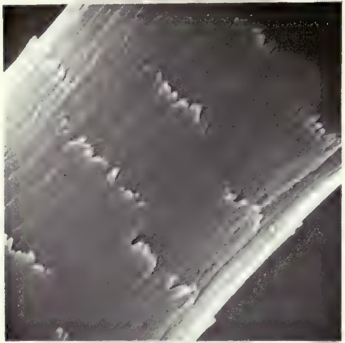

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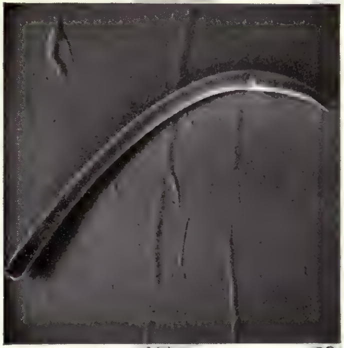

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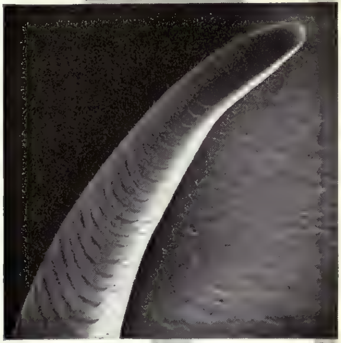

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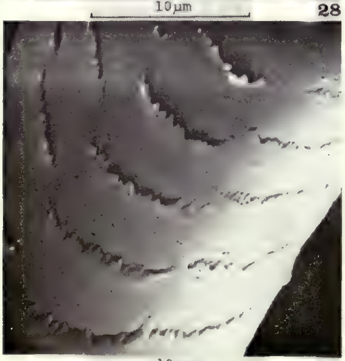

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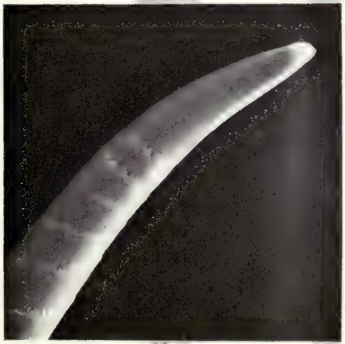

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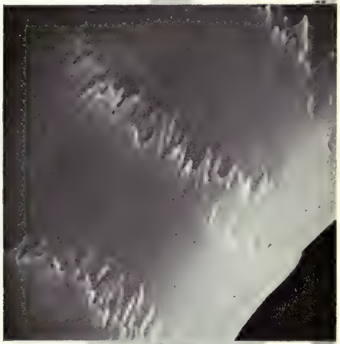

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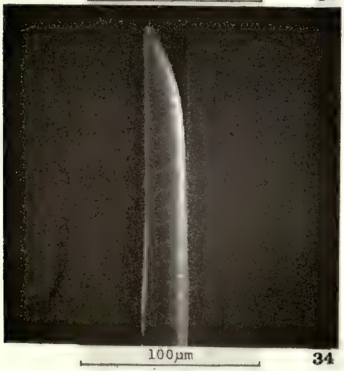

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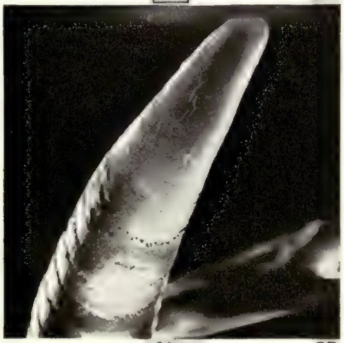

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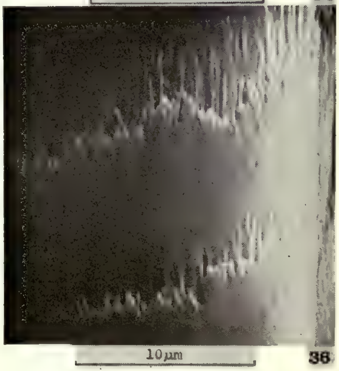
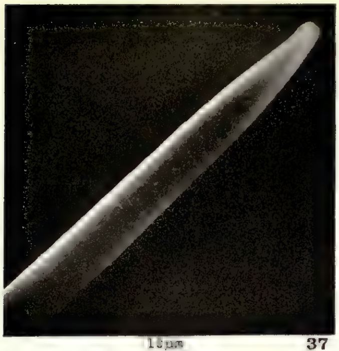


**36**

## PLATES 37–48

Scanning electron micrographs of penial setae. 37–43, *Cryptodrilus polynephricus polynephricus* ad *urethrae* : 37–39, specimen 44 ; 40–42, specimen 48 ; 43, specimen 49.

44–48, *C. p. urethrae* : 44–47, holotype ; 48, paratype 6.



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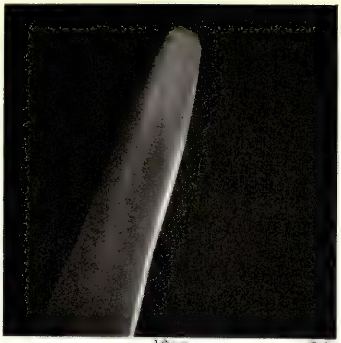

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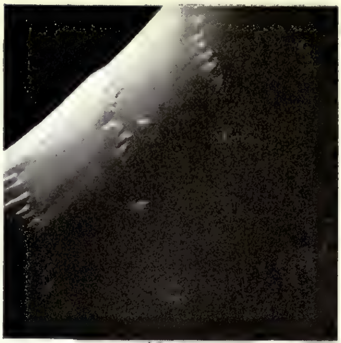

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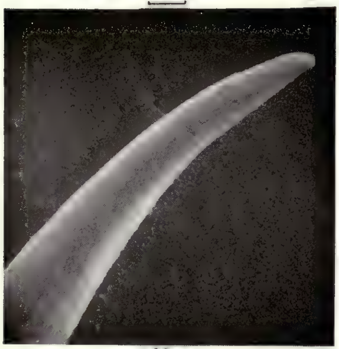

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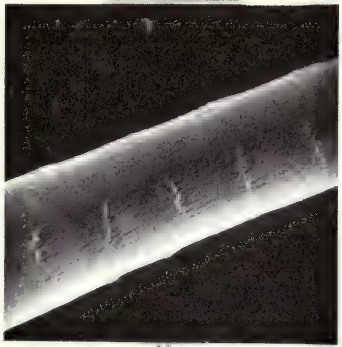

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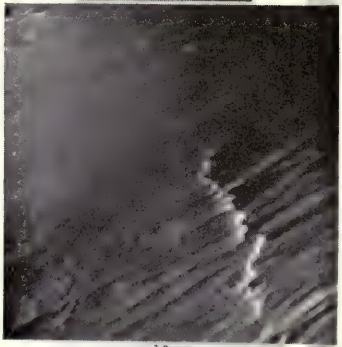

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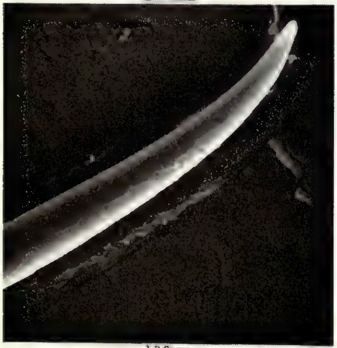

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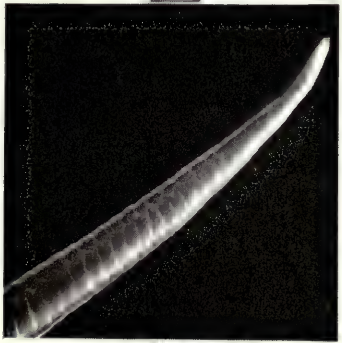

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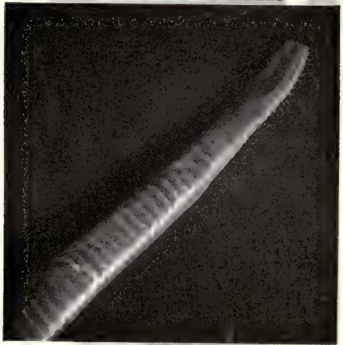

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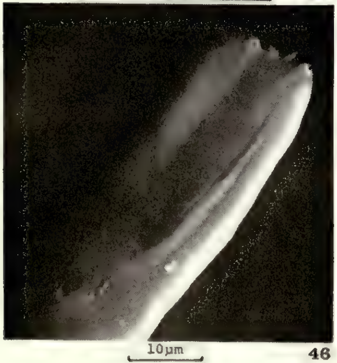

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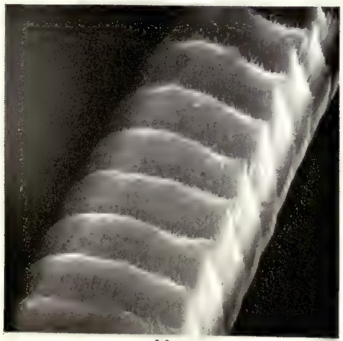

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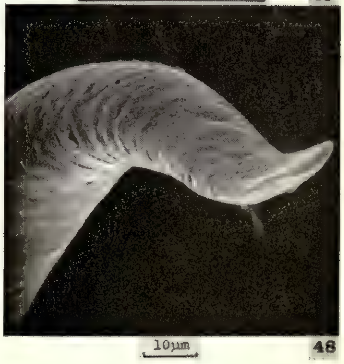
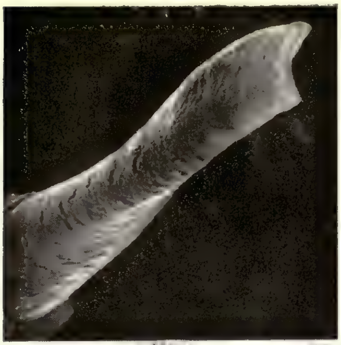


48

## PLATES 49–60

Scanning electron micrographs of penial setae. 49–59, *Cryptodrilus polynephricus urethrae* : 49 & 50, second seta, paratype 6 ; 51 & 52, paratype 20 ; 53–59, 3 penial setae of paratype 1, 53, lateral view of a seta ; 54, ventral view of same ; 55, dorsal view of same ; 56 & 57, lateral and dorsal detail ; 58, lateral view of second seta ; 59, detail of third seta.

60, *Rhododrilus littoralis*, paratype 1.



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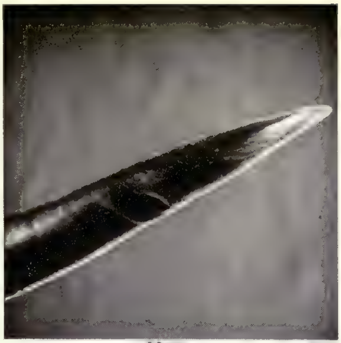

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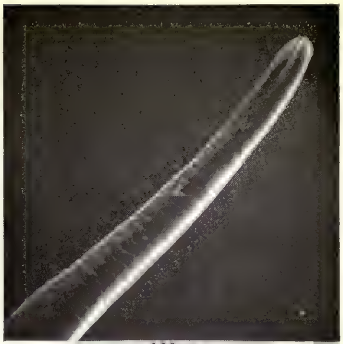

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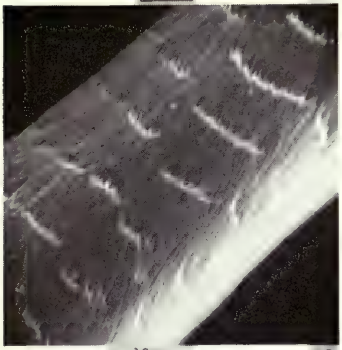

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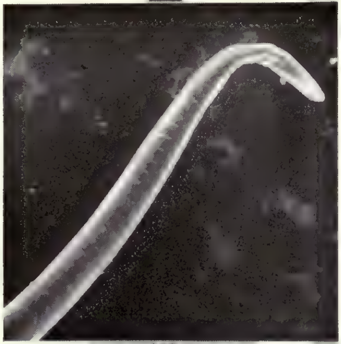

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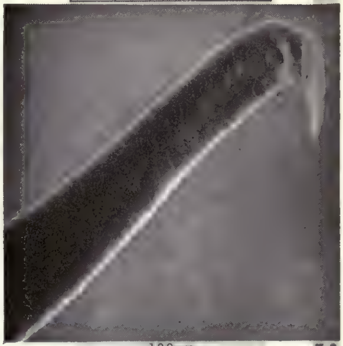

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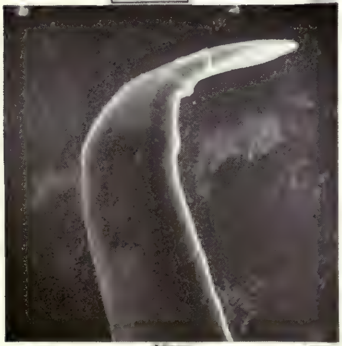

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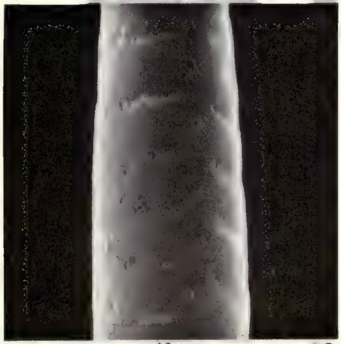

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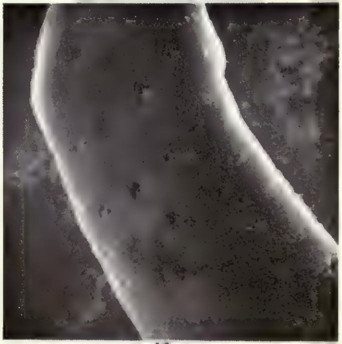

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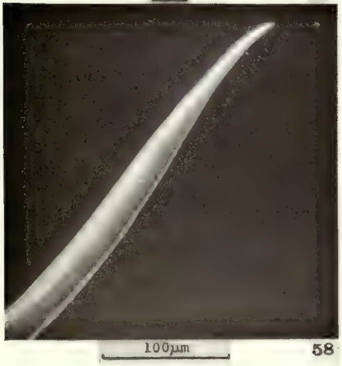

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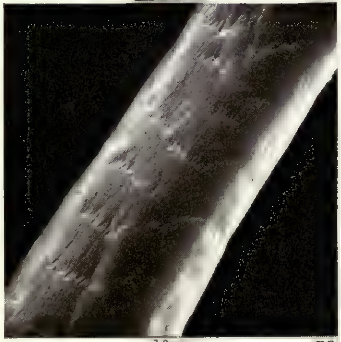

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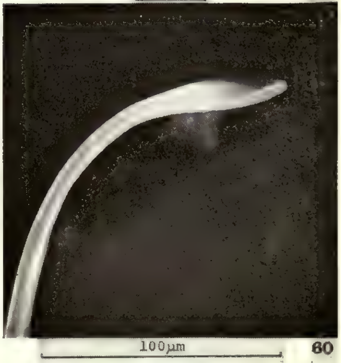

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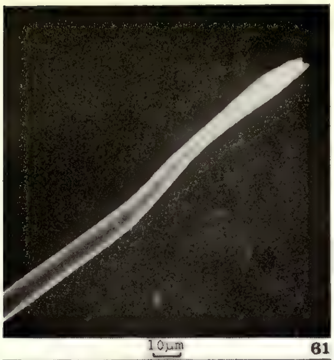
## PLATES 61–72

Scanning electron micrographs of penial setae. 61–63, *Pseudocryptodrilus acanthodriloides*, paratype 3.

64–66, *Hickmaniella opisthogaster*: 64, holotype; 65 & 66, paratype 1.

67, *Oreoscolex bidiverticulatus*, holotype.

68–72, *O. campestris*: 68 & 69, specimen 1; 70–72, specimen 2.



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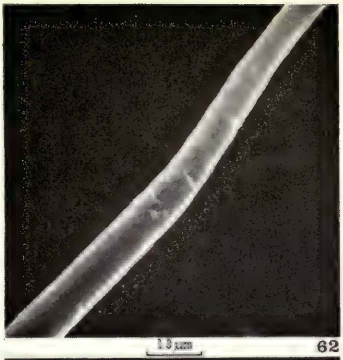

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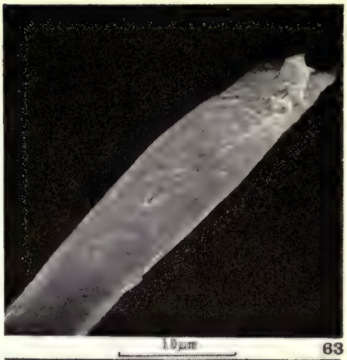

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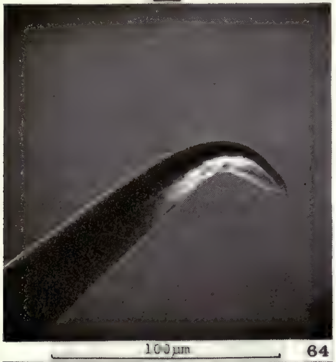

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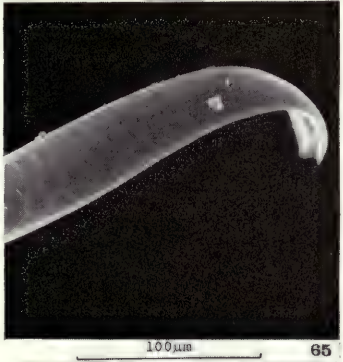

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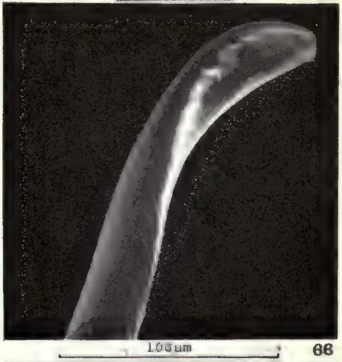

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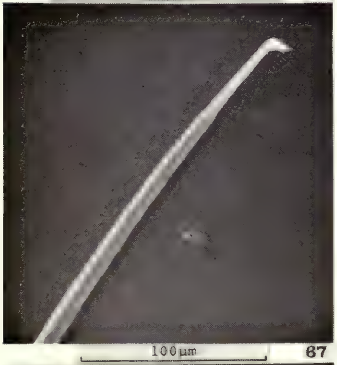

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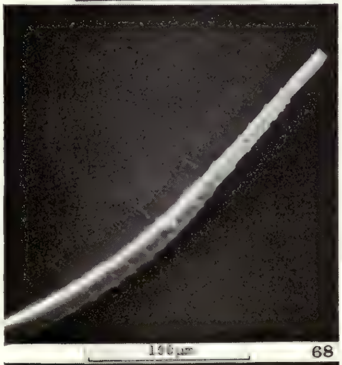

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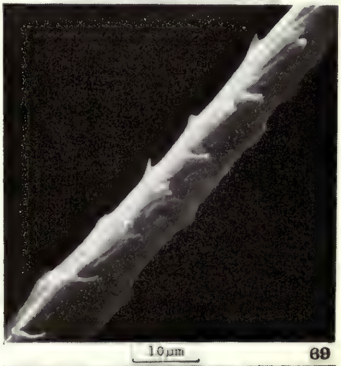

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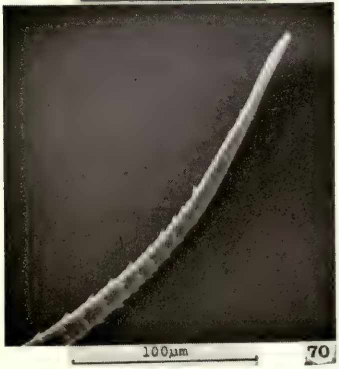

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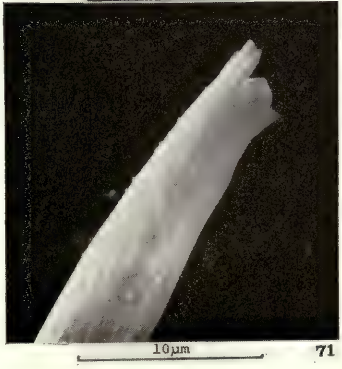

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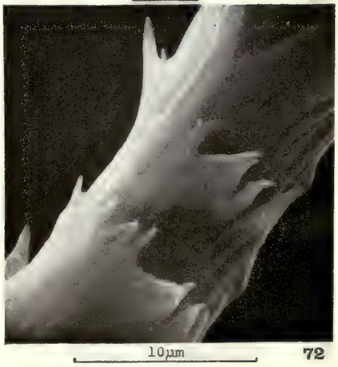

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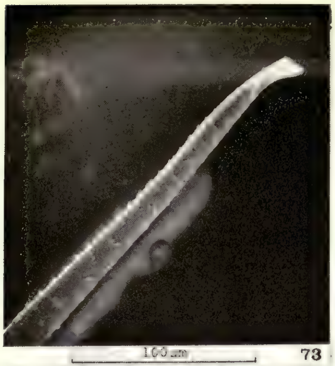
## PLATES 73–84

Scanning electron micrographs of penial setae. 73–80, *Oreoscolex longus* : 73–75, holotype : 76–78, paratype 1 ; 79 & 80, paratype 7.

81–82, *O. peculiaris*, holotype.

83 & 84, *O. sexthecatus*, holotype.



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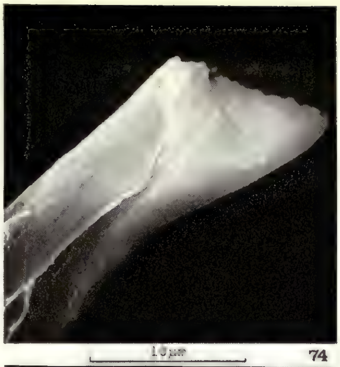

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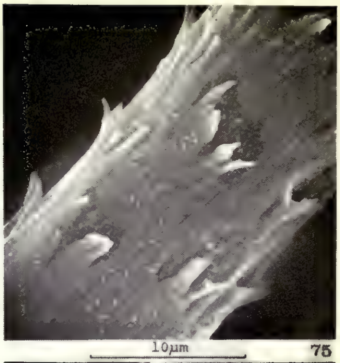

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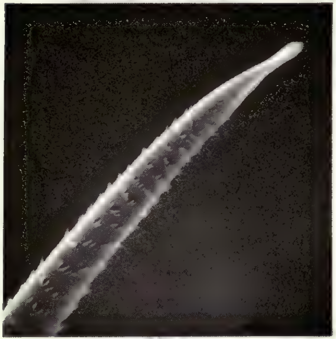

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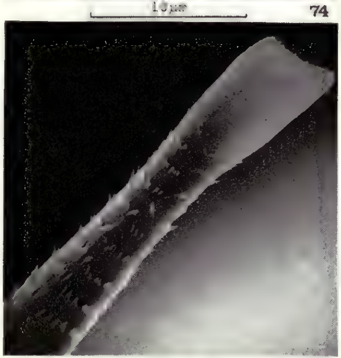

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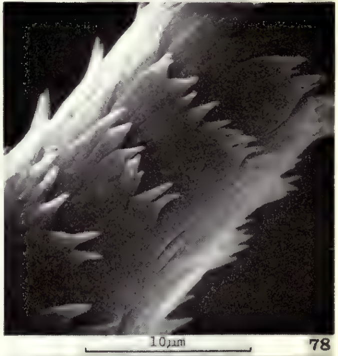

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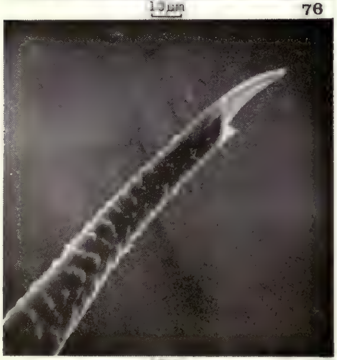

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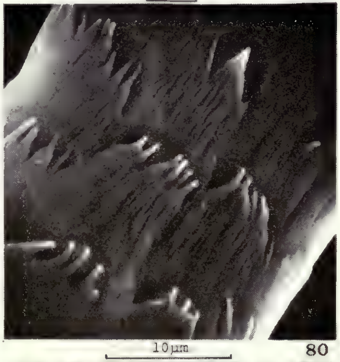

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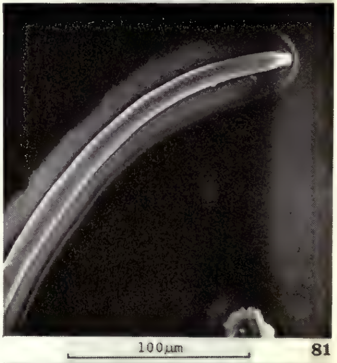

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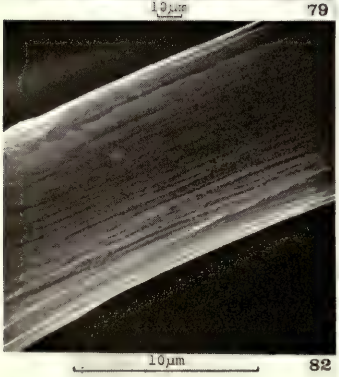

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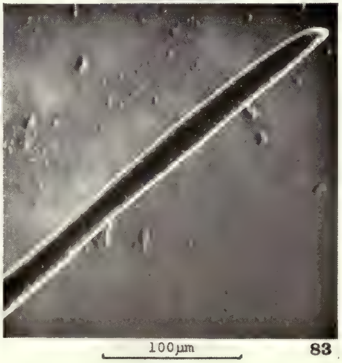

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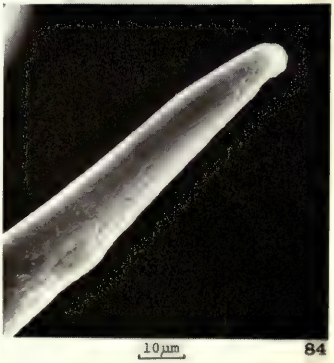

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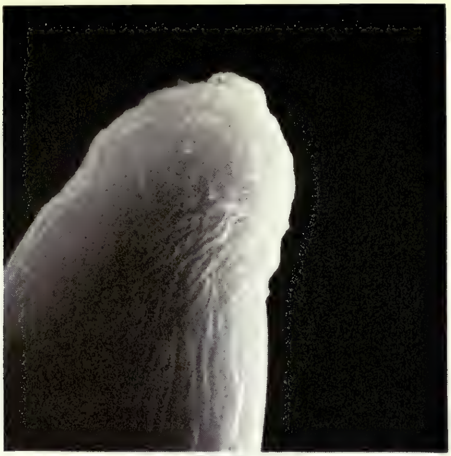
## PLATES 85–90

Scanning electron micrographs of penial setae. 85 & 86, *Oreoscolex sexthecatus*, seta shown in plate 83, holotype.

87–90, *O. wellingtonensis*, specimen 1.



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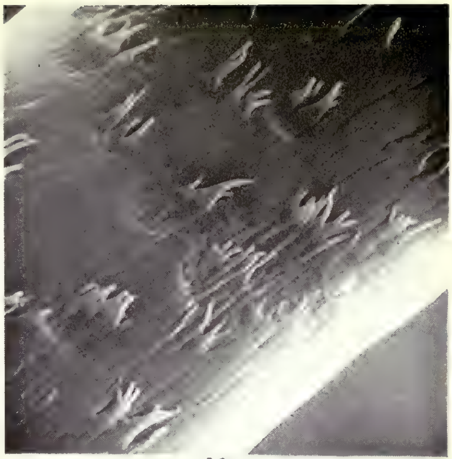

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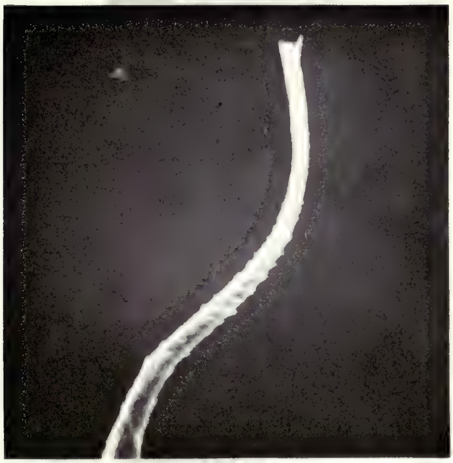

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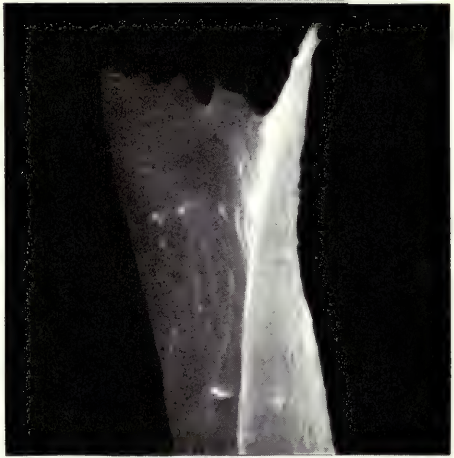

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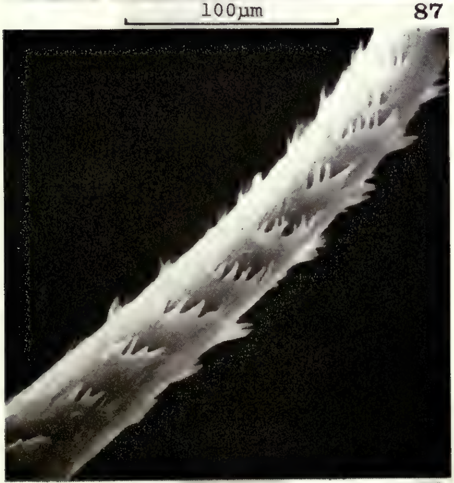

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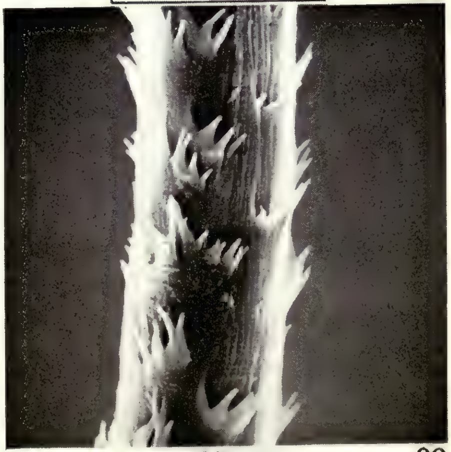

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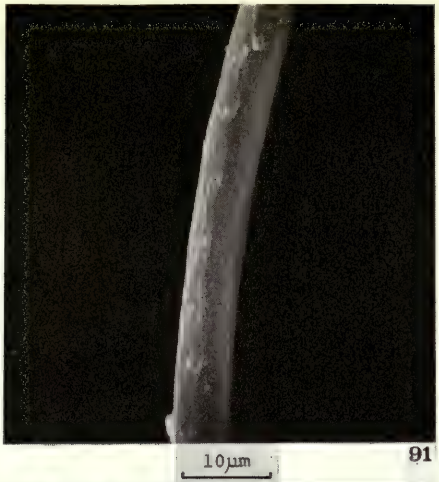
## PLATES 91–96

Scanning electron micrographs of penial setae. 91 & 92, *Perionychella* (*P.*) *capensis*, paratype 1. 93, *P.* (*Vesiculodrilus*) *bithecata*, paratype 3. 94–96, *P.* (*V.*) *dilwynnia*: 94 & 95, Butler's Gorge Road specimen; 96, Tarraleah pipeline specimen.



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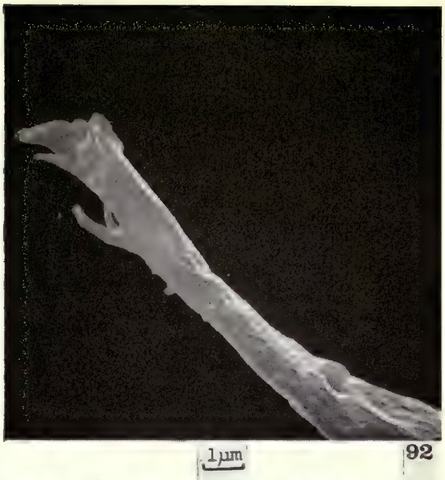

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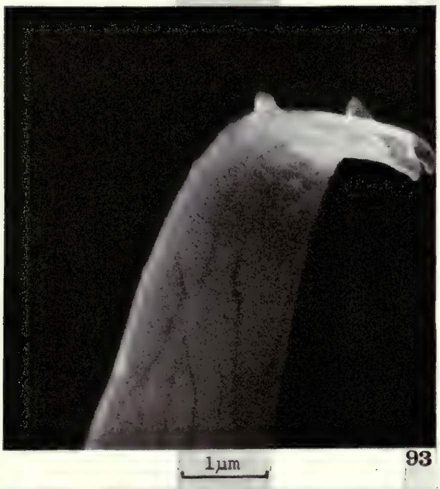

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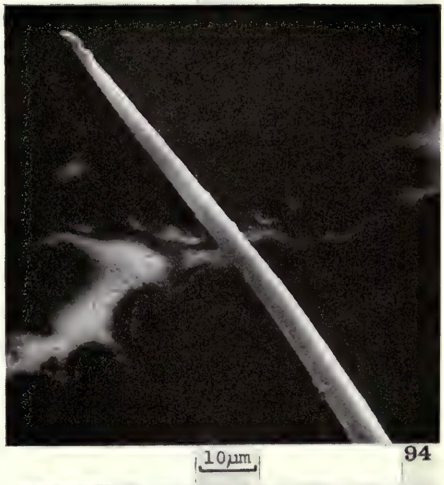

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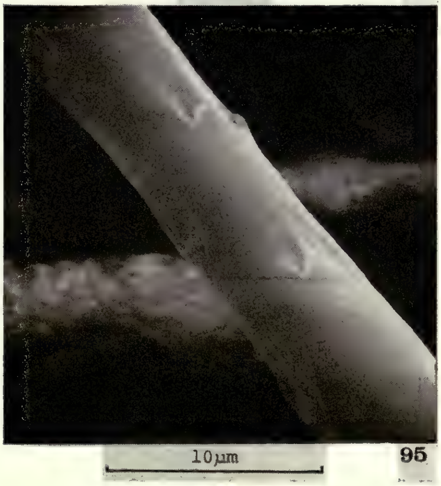

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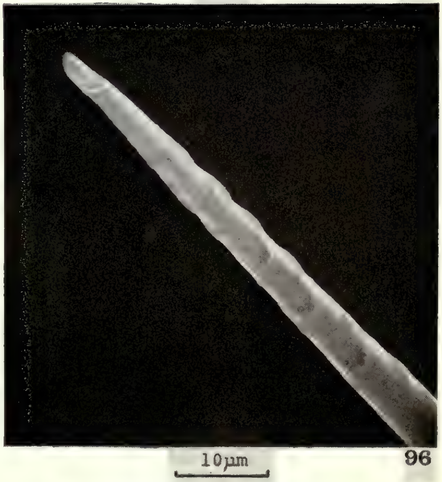

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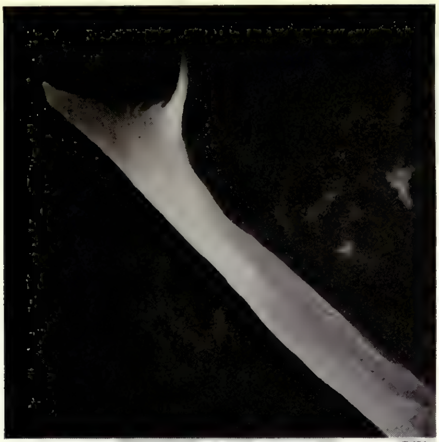
## PLATES 97–102

Scanning electron micrographs of penial setae. 97 & 98, *Perionychella* (*Vesiculodrilus*) *hobartensis* : 97, 14/6, BM(NH) : 1972.8.15 ; 98, 14/5, TM : K304.

99–102, *P.* (*V.*) *mortoni* : 99 & 100, left and right setae respectively of East Risdon specimen ; 101 & 102, specimen described from Shoobridge Bend.



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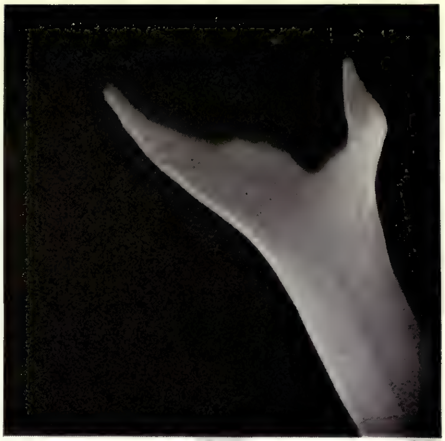

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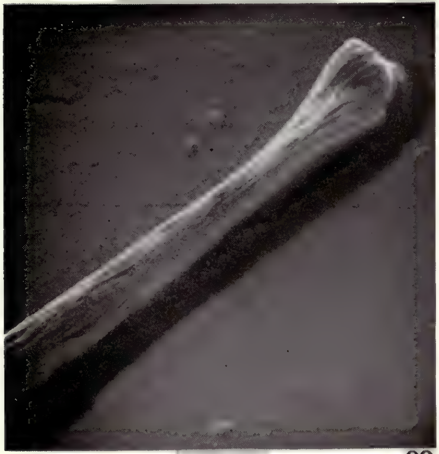

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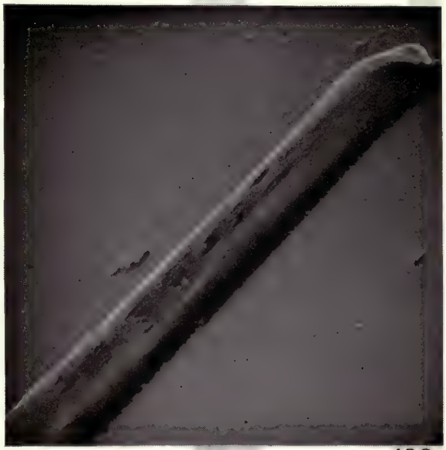

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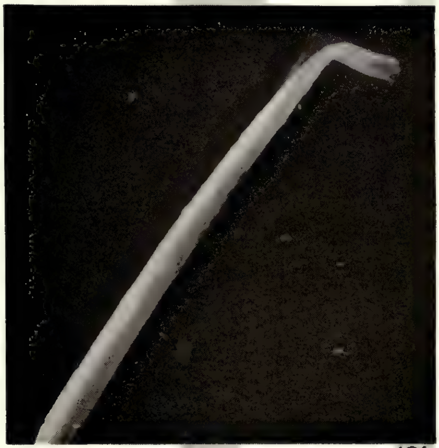

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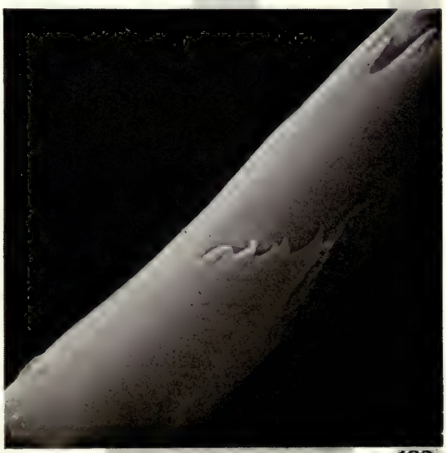

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22 JUL 1974

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E. TREWAVAS

BULLETIN OF
THE BRITISH MUSEUM (NATURAL HISTORY)
ZOOLOGY Vol. 26 No. 5
LONDON: 1974

22 JUL 197
NATURAL HIST

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BY

ETHELWYNN TREWAVAS

*Pp* 329–419; 5 *Plates*, 17 *Text-figures*

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THE BRITISH MUSEUM (NATURAL HISTORY)
ZOOLOGY Vol. 26 No. 5
LONDON: 1974

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*World List* abbreviation :
*Bull. Br. Mus. nat. Hist.* (Zool.)

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*Issued* 24 *May*, 1974 *Price* £5.60

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*By* ETHELWYNN TREWAVAS

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## SYNOPSIS

Collections of fishes from the upper Mungo and its tributaries and from Lakes Kotto, Mboandong and Soden are described and their relationships discussed. The status of *Brienomyrus longianalis* is examined in the light of variation within and between populations of *B. brachyistius*. A new species of *Labeo* is described. The Mungo contains two species of *Barbus* with parallel-striate scales, one of which is given a new name. The three small *Barbus* species with radiating striae on the scales are identical with those of Fernando Poo and one of them, here given a new name, is so far reported only from Fernando Poo and the Mungo and Meme systems. In the course of comparisons with this species records of the geographical distribution of *B. trispilos* and *B. liberiensis* are critically examined and possible synonyms of *B. baudoni* are discussed.

Specimens of *Auchenoglanis* from two localities prompt questions, but no answers, concerning the specific characters within this genus. Two species of *Chiloglanis* were collected in the stony beds of swift streams. One of them is described as new and some special features in the structure of the head in this genus are described.

Seven species of cyprinodonts are recognized in the area, one, a *Procatopus* of Lake Soden, new. The identity and synonymy of *Aphyosemion oeseri* Schmidt are discussed and a new description is given of *Procatopus similis* Ahl.

The structure of the pharynx in *Chromidotilapia* is described, *C. loennbergi* is considered to be a subspecies of *C. guntheri*, a West African species present also in the Mungo together with a new species related to *C. batesii*. The new species is described and compared with samples from Fernando Poo and South Cameroun. The *Hemichromis* of the area is the 'B form of *H. fasciatus*', here tentatively identified with *H. elongatus* Guichenot.

The description of *Tilapia kottae* is amplified and the name *T. camerunensis* Lönnberg is revived for a related species inhabiting the Mungo as well as the Meme and distinct from *T. cameronensis* Holly of the Sanaga system. *T. mariae* of Lake Kotto is no longer considered to merit subspecific rank. Some notes on *Sarotherodon galilaeus* and its subspecies are included.

The Mungo–Meme fish fauna is seen as part of that of the forest zone from western Nigeria to South Cameroun, having none but the most widespread species in common with the Chad basin. Lakes Kotto and Mboandong contain a slightly modified section of this fauna and Fernando Poo harbours twelve species common to it and the Mungo and Meme systems, adapted to life in clear running water. This throws into greater relief the high degree of endemism in the crater lake Barombi Mbo.

## INTRODUCTION

A PREVIOUS paper (Trewavas, Green & Corbet, 1972) dealt with the taxonomy and ecology of the fishes of Barombi Mbo, results of an expedition by three members of Westfield College, University of London, and myself in March–April 1970. The present paper describes the fishes collected during that expedition in the other waters visited. The ecology of those of Kotto and Mboandong has already formed the subject matter of a report by Corbet et al. (1973).

We were interested to get good samples from R. Mungo and its tributaries and from the outflow of Barombi Kotto which belongs to the Meme system, as a background to the endemism in the lakes, especially Barombi Mbo ; and we wished to get further light on the relationships of the Kotto fishes.

For the Mungo collections we are entirely indebted to Dr Henry Disney, who set narrow-meshed traps overnight and used a hand-net to sample the river and its tributaries at and above the bridge near Etam in the course of his field studies of *Simulium* as a vector of *Onchocerca*. When we did not accompany him he brought living fishes to our headquarters near the lake and he made further collections in October and November, 1970.

Kotto, Mboandong and their neighbouring streams were sampled by our colleague Dr John Griffith by means of basket traps and fyke net and by Professor Green and Dr Corbet with hand-nets. In addition we purchased fish from cast-net fishermen and boys with hand-lines.

Comparisons of some species with their representatives in other waters are undertaken as a contribution to West African ichthyogeography.

## DESCRIPTION OF THE LOCALITIES

The lakes have been described (Trewavas, 1962 ; Corbet et al. 1973). The whole area is in the forest zone of the volcanic hills around Mount Cameroon.

R. Mungo at the bridge near Etam is about a quarter of a mile broad. There is a waterfall not far above the bridge and the current is rapid. At our early visits people could wade to the sandbanks exposed in its bed, but before we left heavy rain had swollen it so that the sandbanks were submerged in a broad brown flood.

Between Baduma and Bolo the river was much narrower, clear and shallow, and the same description applies to tributaries from the Blackwater upwards. The bed of the Mangusu was dry at the beginning of our visit, but at the end the stream was in spate and yielded a cyprinodont species.

In the Kotto area, R. Nganjoke, the outlet of Lake Kotto flowing to the Meme, was sampled where it had become a clear shallow stream with rocky bed, in our time crossed by stepping stones but since bridged. R. Nyoke (or Njoke), about a mile S.E. of Lake Kotto, is not connected with the lake but is a tributary of the lower Mungo (information from Dr Disney). The water is clear and is used by the villagers for drinking if, as rarely happens, there has not been enough rain to be collected for that purpose.

The Barombis living on the island in Lake Kotto obtain their drinking water from clear streams (called Tungs) that enter the lake from the crater rim. In these we caught cyprinodonts and *Barbus callipterus*.

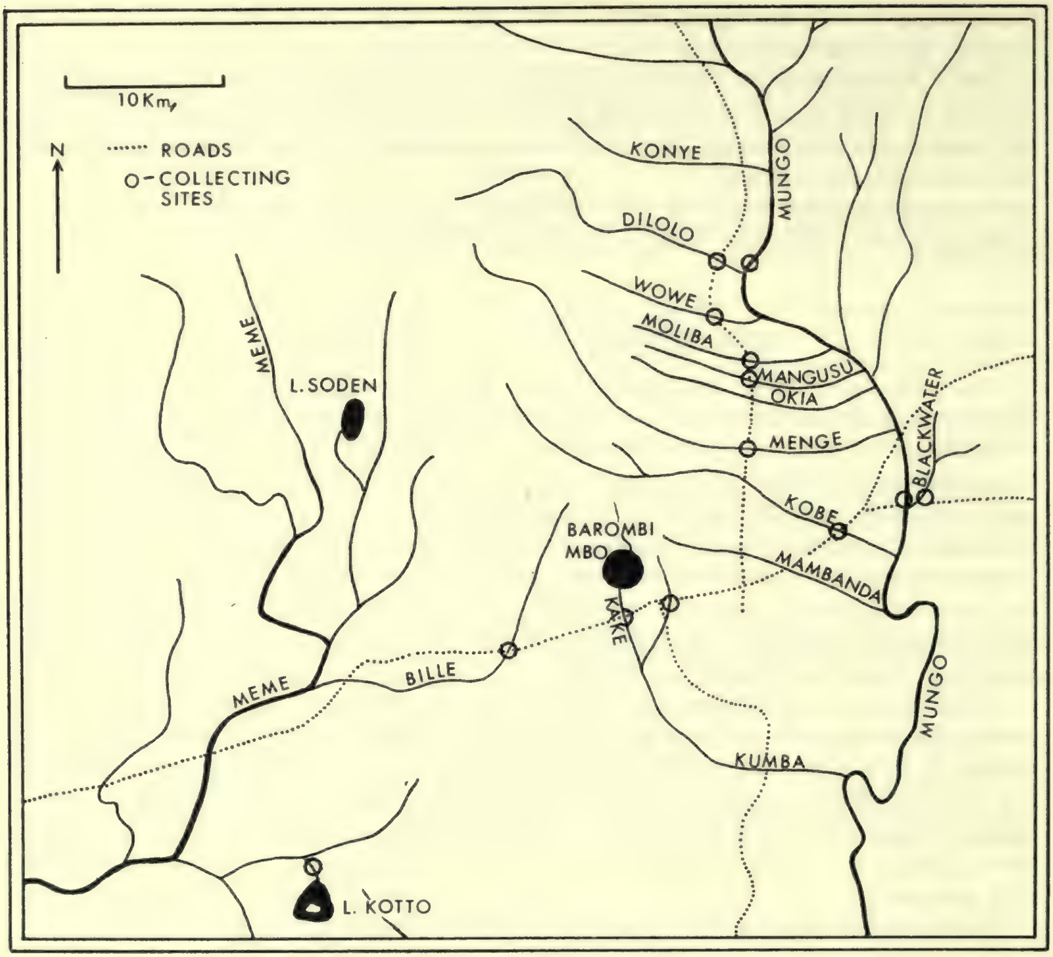
## ABBREVIATIONS AND MEASUREMENTS

BMNH = British Museum (Natural History).

SL = Standard Length, i.e. excluding the caudal fin and (except in *Procatopus*) excluding any projecting part of the lower jaw.

*Interorbital width* in Ostariophysi includes the skinny rim of the orbit (which covers a flexible bony flange). In Cichlidae the callipers are pressed against the skin so that this measurement is virtually that of the bony interorbital part of the roof of the skull.

*Depth of preorbital* in Cichlidae is the depth of the preorbital or lacrimal bone measured from the middle of its orbital edge along a line continuing the radius of the eye.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ROADS
COLLECTING SITES
KONYE
MUNGO
DILOLO
WOWE
MOLIBA
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MENGE
BLACKWATER
KOBE
MAMBANDA
MEME
L. SODEN
BAROMBI MBO
KAKE
BILLE
MEME
MUNGO
KUMBA
L. KOTTO

FIG. 1. Sketch map of the waters of West Cameroon in which the collections were made. Drawn by J. Green from Disney, 1971. The stream Nyoke is the unlabelled one crossing the 'K' of Kotto.

## MORMYRIDAE

### *Mormyrus tapirus* Pappenheim, 1905

Pappenheim, 1905 : 217 ; id. 1907 : 362 pl. xiii fig. 3 (R. Lokundje = Lokoundié, southern Cameroun) ; Boulenger, 1909 : 133 fig. 111 ; Holly, 1927 : 120 (Nachtigal Rapids and R. Mbam, Sanaga system) ; id. 1930 : 225.

*Mormyrus goheeni* (Fowler ?) ; Pellegrin, 1927 : 295 (R. Nyong) ; Holly, 1930 : 225 (from Pellegrin).

Three specimens collected by Dr Disney in R. Wowe, October, 1970, respectively 132, 170 and 173 mm in SL.

These are a little smaller than most previously described specimens, so a description is not superfluous.

Depth of body 20–23·5% SL, length of head 27·6–28·6, length of pectoral fin 17·1–17·4, of pelvic 10·8–12·7, of dorsal base 48·0–48·5, of anal base 16·9–18·3. Length of caudal peduncle 12·9–13·6% SL, 2·8–3·0 times its depth.

Snout narrow and curved downwards to end in the thick-lipped mouth, its length 41–48·5% length of head, 0·9–1·12 times postocular part of head. Diameter of eye 14·5–20·6% length of head.

Scales 84–98 in the lateral line, about 14–17 between lateral line and origin of dorsal, 8–12 from lateral line to origin of anal, 13–16 around caudal peduncle.

Dorsal 62–66, the first ray minute, the next two simple. Anal 24–26, 2 or 3 of which are simple.

Teeth 3 in upper jaw, 6 in lower (but 2 + 3 lower in one, the third of the right side being lost or not yet formed).

The allometries revealed in comparison with earlier descriptions are the usual negative allometry of the eye and the strong positive allometry of the snout. Holly has measured this in terms of the eye-diameter, thus emphasizing the change, but showing continuation of the trend observable even within the narrow size-range of our sample.

Our specimens have fewer teeth in the upper jaw than those formerly described (Pappenheim, Boulenger and Holly 5, Fowler 6 in *M. goheeni*, the last perhaps without realizing the usual presence of a median tooth in Mormyridae). This may also be related to size. Pappenheim and Boulenger found an additional tooth on each side too in the lower jaw, making a total of 8.

Holly has already found in 7 specimens from Rivers Lokundje and Sanaga a range of 60–73 rays in the dorsal fin. It may have been from specimens at the lower end of this range that Pellegrin identified his Nyong specimens as *M. goheeni* (Fowler gave 60, 58 and 61 for the type and two other Liberian specimens). But to my mind the presence of low numbers in samples from Cameroun should rather be taken as evidence that there is one species from Liberia to Cameroun than that two species so defined are present in Cameroun.

The type of *M. goheeni* Fowler (1919 ; Liberia) was described as having 80 scales in the lateral line. The anterior scales are difficult to count because of the thickened skin overlying them and some irregularity in their alignment. The Mungo counts not only include Pappenheim's and Boulenger's count of 90, but bring the range nearer to Fowler's datum and make it more probable that *M. goheeni* is a synonym of *M. tapirus*. There are no records under either name, to my knowledge, between Liberia and Cameroun, and since Fowler's description of the types of *M. goheeni* no further records from Liberia.

## ***BRIENOMYRUS*** Taverne, 1971

Taverne, 1971a : 101 and 108 ; id. 1971b. Type species *Marcusenius brachyistius* Gill.

Taverne shows that this genus is distinguished from *Marcusenius* Gill (type species *Mormyrus cyprinoides* Linnaeus) by the broader, curved mesethmoid, the absence of lateral ethmoids and the presence of 6 circumorbital bones, the antorbital being free from the first infraorbital.

### *Brienomyrus brachyistius* (Gill)

*Marcusenius brachyistius* Gill, 1862 : 139 (Liberia ?) ; Boulenger, 1909 : 67 fig. 50 ; id. 1916 : 158 ; Pellegrin, 1927 : 295 (Wuri and Nyong) ; Holly, 1930 : 222.

*Mormyrus microcephalus* Günther, 1867 : 115 (Ogowe).

*Marcusenius liberiensis* Steindachner, 1894 : 67 (Liberia).

? *Marcusenius longianalis* Boulenger, 1901a : 5 pl. iii fig. 1 (Niger delta) id. 1909 : 69 fig. 51 ; id. 1916 : 159.

? *Marcusenius adustus* Fowler, 1936 : 247 fig. 4 (nr Kribi, Cameroun).

? *Marcusenius* sp. Reed, 1967 : 26 fig. 33.

Our specimens are :

| | SL (mm) | Locality | Collector |
|---|---|---|---|
| 4 | 121–176 | R. Mungo between Baduma and Bolo | R. H. L. Disney |
| 2 | 79·5–133·5 | R. Mungo nr Etam | R. H. L. Disney |
| 5 | 95·5–137·5 | R. Wowe | R. H. L. Disney |
| 1 | 163 | R. Nganjoke | J. Griffith |

The holotype, of unknown locality, 'probably Liberia', had 17 dorsal and 27 anal rays. In Cameroun the species has been recorded from R. Nyong at Dehane, R. Wuri at Yabassi (Pellegrin, 1927), Kribi (Boulenger, 1916 : 158), Tiko near the coast in the R. Matute N. of the Mungo mouth (Trewavas, 1962).

Our Nganjoke fish is slightly deeper-bodied than all but the smallest of the Mungo specimens and has a deeper caudal peduncle. It resembles Boulenger's figure of *B. brachyistius*.

The 11 Mungo specimens are all slender fishes, only the smallest having a maximum depth of more than 18% SL and only one having a caudal peduncle less than 3 times as long as deep. This led me to compare them not only with *B. brachyistius* but also with *B. longianalis* of the lower Niger.

The results, summarized in Tables 1 and 2, make it difficult to maintain *B. longianalis* as a separate species. According to Boulenger's key (1909 : 61) the only trenchant contrast is in the number of anal rays (31–33 v. 25–30). But one of the syntypes of *M. microcephalus* Günther (R. Ogowe), synonymized by Boulenger with *brachyistius*, also has 31 anal rays and 6 other specimens from the Lower Niger, included in *longianalis*, have 30–32. It is no longer justifiable therefore to draw an arbitrary line between 30 and 31 rays. It is nevertheless true that in the lower Niger long anals are associated with low numbers of dorsal rays (Table 3). Elsewhere high anal counts are associated with rather high numbers of dorsal rays (Sierra Leone and R. Gambia) or low dorsal counts with low numbers of anal rays (Niari-Kouilou, Chiloango and Congo) (Table 3). In the Mungo the slender shape is associated with intermediate numbers of dorsal and anal rays, although the anal numbers range higher than in the presumed type locality (Liberia).

TABLE 1

Some critical characters in samples of *Brienomyrus brachyistius* and possible synonyms

| | *n* | D | A | A/D | sc. | depth | c.p.l/d | vert. |
|---|---|---|---|---|---|---|---|---|
| Liberia | 10 | 17–18 | 24–27 | 1·5–2·0 | 56–63 | 20·6–24·8 | 2·2–2·9 | 44–45 |
| Ghana and nr Lagos | 5 | 15–16 | 27–28 | 1·95–2·25 | – | 17·2–22·5 | 2·6–3·3 | 44–45 |
| Nr Oban, Calabar | 3 | 16–17 | 28–29 | 1·9–2·2 | – | 18·5–20·6 | 2·6–3·1 | 45, 46 |
| Mungo | 11 | 16–18 | 27–29 | 1·6–2·0 | 59–65 | 14·2–20·4 | 2·9–4·0 | 44–47 |
| Nganjoke | 1 | 17 | 26 | 1·9 | 55 | 17·8 | 2·6 | 45 |
| Type of *B. microcephalus*, Ogowe | 1 | 17 | 31 | 2·2 | 59 | 18·8 | 3·2 | 45 |
| Types of *longianalis* | 2 | 15, 16 | 32, 33 | 2·9, 3·1 | 60 | 17·5, 21·7 | 3·1 | 46, 47 |
| Others from Niger delta | 5 | 14–16 | 30–32 | 1·9–2·75 | 54–61 | 18·5–22·3 | 2·9–3·5 | 45–48 |
| Tiko, Cameroon | 1 | 16 | 30 | 1·9 | 64 | 22·3 | 2·9 | 47 |
| Kribi | 1 | 17 | 28 | 2·25 | 65 | 19·8 | 3·9 | 47 |
| Others from Ogowe | 10 | 15–17 | 27–30 | 2·2–2·4 | 59–61 (in 4) | 20·2–23·0 | (2·9) 3·1–3·8 | 45–47 |

*n* = no. of specimens, D = dorsal fin-rays, A = anal fin-rays, A/D = length of anal base/length of dorsal base, sc = scales in lateral line, depth = max. depth as % SL, c.p.l/d = length of caudal peduncle/its depth, vert. = vertebrae. The Liberian samples include three syntypes of *M. liberiensis*.

TABLE 2

*B. brachyistius* from the extremes of its geographical distribution. Data as in Table 1

| | *n* | D | A | A/D | sc. | depth | c.p.l/d |
|---|---|---|---|---|---|---|---|
| Sierra Leone | 9 | 16–18 | 27–31 | 1·6–2·1 | (55) 59–63 | 18·6–23·4 | 2·3–3·3 |
| R. Gambia (Daget) | 1 | 18 | 30 | 1·9 | 56 | 21·8 | 2·85 |
| Chiloango | 6 | 15–16 | 25–27 | 1·8–2·1 | 51–56 | 17·6–22·0 | 2·6–3·0 |
| Matadi | 1 | 13 | 26 | 1·8 | 53 | 22·2 | 2·4 |
| 'Stanley Falls' | 1 | 15 | 25 | 1·8 | 50 | 22·9 | 2·55 |
| Niari-Kouilou (Daget) | 5 | 15–16 | 25 | | | | |

TABLE 3

Frequencies of dorsal and anal fin-ray counts in samples of *Brienomyrus*

| | Dorsal | | | | | | Anal | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 13 | 14 | 15 | 16 | 17 | 18 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 |
| Liberia | | | | | 9 | 3 | 1 | 4 | 4 | 3 | | | | | | |
| Mungo | | | | 4 | 6 | 2 | | | 1 | 5 | 2 | 3 | | | | |
| '*microcephalus*' and '*longianalis*' | | 1 | 4 | 3 | 1 | | | | | | | | 2 | 2 | 4 | 1 |
| Sierra Leone and Gambia | | | | 3 | 4 | 4 | | | | 3 | 2 | 1 | 4 | 1 | | |
| Congo, Chiloango and Niari-Kouilou | 1 | | 5 | 7 | | | | 7 | 5 | 1 | | | | | | |

Such evidence as we have suggests variation both within and between populations no more than may reasonably be expected in a species occupying the lower reaches of a series of river-systems. Although it is not a typical inhabitant of coastal lagoons, Daget & Iltis (1965) record that it is tolerant of brackish water, so that the possibility of occasional interchange between neighbouring populations is not excluded, perhaps in a geological rather than an historical time-scale.

The comparative material used for Tables 1–3 is that listed by Boulenger in vols I and IV of his *Catalogue* under *M. brachyistius* and *M. longianalis* with the additions listed below. Some doubt attaches to the locality of the specimen from 'Stanley Falls' since Poll & Gosse (1963) did not find *B. brachyistius* in the Yangambi region, nor did they include it in their list of species recorded from the Central Congo. The collection by De Meuse in which it was included contained examples of several species from Stanley Pool and of two others from Stanley Falls, *Stomatorhinus microps* Boulenger and *Gnathonemus petersi* Günther. Both the latter are found throughout the Central Congo as well as in Stanley Pool and the Lower Congo, so that they do not provide the confirmation we seek that De Meuse's collection of that date really included fishes from Stanley Falls.

Boulenger's material included syntypes of *M. liberiensis*, *M. microcephalus* and *M. longianalis*.

The specimen (BMNH 1970.10.13.1) registered as from 'Lokoja R. 1967' may be one of the two referred to by Reed (in Reed et al. 1967 : 26 fig. 33) from a swamp near Idah. He described them as resembling *M. brachyistius* but having a shorter pectoral fin and a total length of 180 mm. The length of our specimen is now only 166 mm. In it the right pectoral fin is reflected forwards, but both pectorals when laid back extend just beyond the origin of the pelvics, as is usual in *B. brachyistius*. The short appearance of the fin in Reed's sketch may be accounted for by the fact that the drawing was traced from a photograph, possibly with a foreshortened fin. This fish, with 15 dorsal and 30 anal rays and a long slender caudal peduncle, resembles the types of *M. longianalis* and others from the Niger delta (Table 3).

Fowler's account of *M. adustus* (1936) compares it with *M. batesii* Boulenger, but this species has 16 scales around the caudal peduncle and fewer anal rays. Fowler did not mention the peduncular scales but his drawing shows fewer than 16. If we assume that he undercounted the lateral line scales his specimens may well belong to *B. brachyistius*.

*B. brachyistius* : material in the BMNH additional to that listed in Boulenger's *Catalogue* and on p. 336 above.

| BMNH register no. | SL (mm) | Locality | Collector |
|---|---|---|---|
| 1938.12.15.31 | 102 | Akim, nr Bunsu, Ghana | F. R. Irvine |
| 1932.2.27.8 | 121·5 | Onitsha | F. R. Irvine |
| 1970.10.13.1 | 150·5 | 'Lokoja R' | W. Reed |
| 1952.4.1.5 | 89·5 | Tiko, Matute R. Cameroun | J. Deveson |
| 1950.9.22.1–5 | 49–68 | S.W. Sierra Leone | T. S. Jones |
| 1958.9.18.8 | 107 | S.W. Sierra Leone | T. S. Jones |

## CHARACIDAE

### *Alestes macrolepidotus* (Val.)

*Brycinus macrolepidotus* Valenciennes, 1849, in Cuvier & Valenciennes vol. 22 : 157 pl. 639 (Senegal).

Three specimens, 42·5–58·5 mm in SL from R. Mungo at the bridge near Etam, coll. Dr Disney, 18 March 1970 and 4 Nov. 1970.

This widespread species, recorded from the Nile, West Africa and the Congo, was caught by us only in the part of the Mungo corresponding to its habitat in the Yangambi region, where Gosse (1963) states that it is found near the banks and along sand banks.

Our specimens were not full grown and were even more slender than adults (depth 26·1–29·2% SL). The gill-rakers were rather fewer than the number given by Boulenger for the species, (7–13) + (0–1) + (15–16) on the first arch. The presence of 10 outer teeth in the upper jaw, with the second from the symphysis inset, out of alignment with the rest, is characteristic. The dorsal formula is ii–iii 7 or 7 + 1, the anal iii 11–12. There are 23 or 24 scales in the lateral line, 4½ rows between it and the origin of the dorsal fin, 1½ from lateral line to pelvic.

Colour notes made from the smallest specimen when it had been 1¾ hours in formalin describe the body as pale gold and grey, the dorsal fin with pink tinge and grey leading edge, adipose red, caudal lobes yellow with orange tinge on upper and lower edges ; a diffuse dark blotch at end of caudal peduncle continued as a black streak on middle caudal rays. In the preserved specimens a dark mark behind the pectoral girdle is more evident in one specimen that was fixed in formalin than in the others where alcohol was the fixative.

### *Alestes longipinnis*

*Brachyalestes longipinnis* Günther, 1864, Cat. Fish. vol. 5 : 315 (Sierra Leone).

One specimen from the Mungo bridge near Etam is 76 mm in SL. It is probably male, having the longest dorsal fin-ray 140% length of head (near the values obtained by Thys, 1967 : 31). The lateral line scales number 31 + 1, rows between lat. line and dorsal origin 5½, between lat. line and pelvic 2½. Dorsal ii 8, anal iii 19 + 1. Teeth in upper jaw 6 outer, evenly aligned, 8 inner ; in lower jaw 8 + 2. Gill-rakers on first arch 10 + 1 + 10, the epibranchial ones very short.

No notes were made on our living specimen, but colour notes accompanying one collected in 1952 by Mr Deveson in R. Matute near Tiko agree essentially with those published by Loiselle (1972) for the species in West Africa, as follows : eye brilliant gold (iris silvery-yellow with orange crescent on top – Loiselle) ; black mark on caudal peduncle and middle caudal rays with gold above it (metallic orange above it); dorsal, adipose, caudal and anal fins with dashes of red (D, C and A rosy violet, D orange basally). Loiselle adds that the long dorsal and anal filaments of mature males are metallic white. From Thys's (1967) account including comparisons with specimens from the extremes of its distribution, the colour may be more variable. In particular, the prolongations of dorsal and anal fins may be reddish.

The species inhabits flowing water with forest shade from Guinea Republic to R. Kribi (excluding the Volta and the Dahomey gap), as well as similar habitats in Fernando Poo.

## CYPRINIDAE

### ***Labeo camerunensis*** n. sp.

Pl. 3

Holotype. 162 mm SL from R. Mungo at the bridge near Etam, coll. Dr Disney. BMNH 1973.5.14.324.

Paratypes. Two of SL 167 and 175 mm from R. Wowe and two young of 43 and 45·5 mm from R. Mungo between Baduma and Bolo, all coll. Dr Disney. BMNH 1973.5.14.322–3, 325–6.

These fall into a group of *Labeo* having the following characters: eyes superolateral, snout much longer than postocular part of head, dorsal fin iii–iv 9–10, its longest ray not or but little longer than head and its dorsal edge concave; 16 scales around caudal peduncle.

The branched dorsal rays are 9 in four specimens, 10 in one. The snout is tuberculate, without a deep furrow between the ethmoid and the jaw, projecting a short way in front of the broad mouth. A maxillary barbel is present, hidden in the folds of the lip in adults; a short rostral barbel is present in one of the young, represented by a stump or absent in the others.

There are 35 or 36 scales in the lateral line, excluding 1–3 on the caudal fin, 4½–5 rows above the lateral line in front of the dorsal fin, 3–3½ between the lateral line and the pelvic.

Proportions in the three adults are:

*As % SL*: depth of body 22·7–23·8; length of head 24·7–25·2; length of caudal peduncle about 16–17, its depth 12·6–13·0; length of longest dorsal ray 23·0–26·2; length of pectoral fin 24·2–25·0.

*As % length of head*: diameter of eye 20·0–20·7; length of snout 55·2–58·5, 1·65–2·02 times postocular part of head including skinny edge of operculum; interorbital width 41·6–46·2.

Colour fairly uniform on back and sides, each flank scale in life reddish purple with a black base overlapped by the transparent posterior edge of the preceding scale. Lower side of head and belly white or pale grey.

The two young already have the adult characters of large, superolateral eyes (25·5, 26·0% length of head), a well-developed snout with some tubercles and the edge of the dorsal fin slightly concave. There is a large round black blotch on each side at the end of the caudal peduncle and a suggestion of a darker band along the middle of the side.

Affinities. *L. annectens* Boulenger, described from R. Kribi and neighbouring rivers, has only 12 scales around the caudal peduncle (14 in one of 8 specimens examined), but is evidently nearly related to our species. *L. batesii* Boulenger, 1911 and 1916, is known in the adult state only from the type, from R. Kribi, a fish of SL 169 mm with a broken neck. Some young, up to 21·5 mm SL, from R. Benito have been attributed to it by Roman (1971). The drooping head of Boulenger's figure (1916, fig. 127), a restoration, is partly the result of damage, but the high curved back and deep body (28·4% SL) are natural and contrast with the Mungo fishes, whose dorsal outline is continued almost horizontally into the line of the top of the head and snout. The caudal peduncle of *L. batesii* is not only deeper (14·8% SL) and shorter (14% SL), but more compressed than in *L. camerunensis*. The scale numbers are only a little higher than in the Mungo fish, those around the caudal peduncle likewise 16, and the length of the longest dorsal fin-ray is comparable (23·6% SL).

From the Sanaga system Holly has recorded (1927a : 131 ; 1927b : 421 ; 1930) *L. greenii* Boulenger and Pellegrin named *L. chariensis* var. *nunensis* (1929a). Holly gives no details but Pellegrin distinguished his 'variety' from *L. chariensis* by the smaller and more numerous scales (l.l. 39, D to l.l. 5½) and this would place it in *L. greenii* (l.l. 37–38, D to l.l. 5½–6½). Both *L. chariensis* and *L. greenii* are further distinguished from the Mungo form by the very long last simple dorsal fin-ray (37–43% SL in *L. greenii*, about the same in *L. c. nunensis*). These differences outweigh a resemblance in the pigment pattern between the young of the Mungo form and *L. greenii*, which has a conspicuous black blotch at the end of the caudal peduncle persisting, though more vaguely delimited, at a standard length of 182 mm (see Boulenger's original figure, 1902, pl. viii fig. 4). Pellegrin mentions no pattern except the usual countershading, but the syntypes of *L. c. nunensis* were bigger (SL 260 and 330 mm) than Boulenger's specimens of *L. greenii*.

*L. mungoensis* is a member of or closely related to the super species including *L. forskalii*, and *L. cylindricus*, having a lower number of scales than these, but not as low as *L. annectens*. A dark lateral band is found also in the young of these species.

## ***BARBUS*** Cuvier & Cloquet, 1816

I. Species with parallel-striate scales and with the last simple dorsal ray thick and rigid in its proximal part, but not serrate.

Our samples of this group comprise 75 specimens, of which 39 are young fry, 26–56 mm in SL. Good samples of adults were taken in R. Nyoke, Barombi Mbo and R. Wowe ; R. Menge yielded one of 92 mm SL. In addition there were 14 from Lake Soden (p. 345).

These agree in numbers of scales and fin-rays and in having two pairs of barbels, the posterior in adults longer than the diameter of the eye (up to twice), and in the pharyngeal dentition, but they fall into two groups on the length of the strengthened dorsal ray and its rigid part.

The ray is longer and stronger in adults from Rivers Wowe and Menge than in those from Barombi Mbo and R. Nyoke. This seemed to be the only character differentiating them and as it has been found variable in some other populations I was uncertain of its significance until I examined the fry. These have longer dorsal

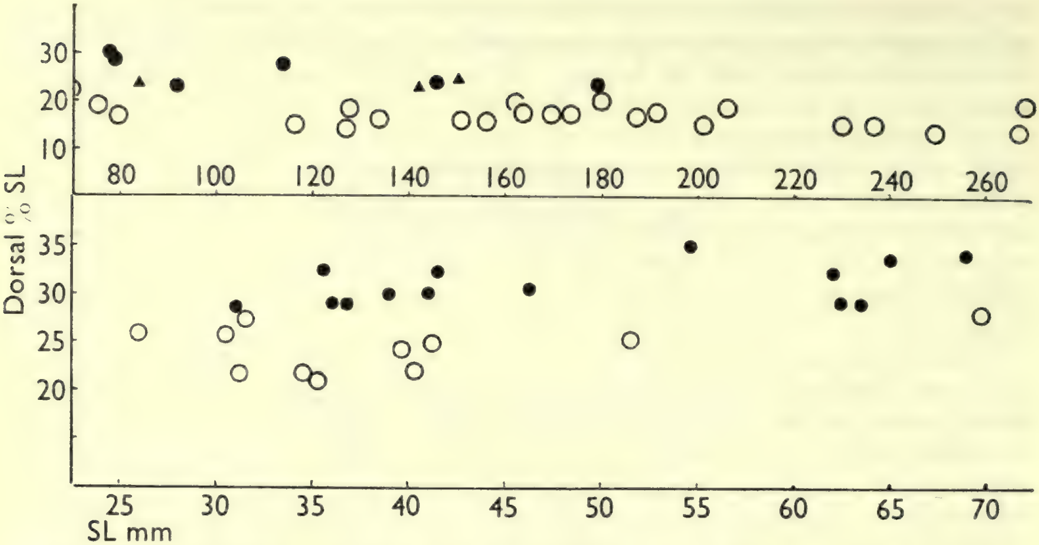

FIG. 2. *Barbus batesii* (open circles) and *B. mungoensis* (solid circles). Length of longest dorsal ray as % SL in (above) adults and (below) juveniles. For adults only the rigid part of the ray is measured, for juveniles the whole ray. With the adult *B. batesii* are included the holotype and 3 other Kribi specimens ; the rest are from Barombi Mbo and R. Nyoke. Triangles are ratios from Holly's (1927) measurements of *B. brevispinis*.

and caudal fins associated with longer barbels, shorter fins with shorter barbels. The time and/or rate of development of the barbels is a feature that Barnard (1943 : 147) found useful in differentiating the species of South Africa.

It happens that we have a good series from fry to adults from only one locality, R. Wowe (Dr Disney's collection), but this gives confidence in the taxonomic value of the length of the stiffened dorsal ray at a size when the difference in barbel-length has been outgrown.

Having separated the adults on this basis, I was able to find some taxonomic significance in the degree of development of the lips, a notoriously variable character, as many authors from Günther (1868 : 84) to Daget & Iltis (1965 : 99) have emphasized. It seems that in the short-finned species, which I identify with *B. batesii* Boulenger, the lip may become lobed, but only in large adults ; in the long-finned species, to which I have reluctantly given a new name, quite small specimens may develop the lobe.

The two species are contrasted as follows :

*B. batesii*

Last simple ray of dorsal fin 17–24% SL in adults of 116–314 mm SL, shorter than head ; its rigid part 14–20% SL. Lower lip with a median pad, more or less undercut, sometimes produced as a lobe in individuals over 200 mm SL. Posterior barbel in fry of 33–53 mm SL 34·5–50·0% diameter of eye.

*B. mungoensis* n. sp.

Last simple ray of dorsal fin 25·5–30·0% SL in adults of 114–180 mm SL, as long as or longer than head; its rigid part 24·5–28·0% SL, 92–104% length of head. Lower lip with an undercut or fringed median pad or with a lobe. Posterior barbel in fry of 25–56 mm SL 71–100% diameter of eye.

## ***Barbus batesii*** Boulenger, 1903

Boulenger, 1903 : 25 pl. iii fig. 2 (R. Kribi) ; id. 1911 : 43 fig. 24 ; Trewavas, 1962 : 152 (Barombi Mbo) ; Thys van dem Audenaerde, 1967 : 34 figs. 11, 12 (Fernando Poo).

In addition to the material listed by me in 1962, we now have, from our collections of 1970 and one made by Dr C. A. Wright in 1963, the following (see also p. 345) :

| | SL (mm) | Locality |
|---|---|---|
| 18 | 69·5–267 | Barombi Mbo and its feeder stream |
| 17 | 27–53 | R. Kumba above the falls |
| 2 | 27 and 41 | R. Kumba at Buea Road Bridge |
| 6 | 28–50 | R. Menge |
| 4 | 155–202 | R. Nyoke |

Proportions, for three size-groups from Barombi Mbo with a separate column for R. Nyoke, are set out in Table 4 and proportions for fry up to SL 53 mm are listed in Table 7 and Fig. 2.

TABLE 4

Proportions in *Barbus batesii* in Barombi Mbo and R. Nyoke

| | Barombi Mbo | | | Nyoke |
|---|---|---|---|---|
| SL (mm) | 202–267 | 116–191 | 69·5–78·0 | 156·5–202 |
| *N* | 4 | 11 | 3 | 4 |
| Depth of body (% SL) | 24·4–27·8 | 24·8–27·4 | 24·8–29·5 | 27·8–29·4 |
| Length of head (% SL) | 23·8–26·6 | 24·5–27·5 | 26·8–28·0 | 27·7–28·9 |
| Last simple D ray | | | | |
| (% SL) | 17·0–20·3 | 18·9–24·0 | 22·4–28·0 | 19·8–21·2 |
| (% length of head) | 67·5–85·0 | 71·5–89·0 | 80·0–100·0 | 69·0–77·0 |
| Rigid part of ray | | | | |
| (% SL) | 14·0–16·6 | 18·0–20·0 | 16·5–22·0 | 16·0–17·0 |
| (% length of head) | 54·0–70·0 | 54·0–74·0 | 60·0–80·0 | 55·5–59·0 |
| Length of pectoral (% SL) | 21·0–22·2 | 20·0–23·0 | 22·0–23·0 | 22·0–24·5 |
| Length of anal (% SL) | 19·5–20·5 | 19·0–23·5 | 21·0–21·5 | 20·0–24·5 |
| Length of caudal lobe (% SL) | 24·8–30·4 | 26·0–30·5 | 28·8–31·6 | 26·8–28·0 |
| Snout (% head) | 33·3–39·0 | 32·0–39·0 | 31·0–34·5 | 34·0–39·8 |
| Eye (% head) | 18·6–20·8 | 19·0–30·0 | 28·5–32·0 | 22·5–23·5 |
| Interorbital width (% head) | 34·8–36 | 31·4–36·0 | – | 30·0–34·5 |
| Posterior barbel/eye | 1·2–1·55 | 1·0–1·7 | 0·75–1·0 | 1·15–1·5 |

Scales 24–26 : 4½ (5) : 2–2½. 5½ between origin of dorsal and lateral line on one side of one fish. Dorsal iii–iv 8–9 in Barombi Mbo, iv 9–10 at R. Nyoke. Gill-rakers (2–4) + (0–1) + (9–11) at Barombi Mbo, (2–4) + 1 + (11–13) at R. Nyoke.

Colour in life brassy yellow on the flanks, countershaded to dark green on the back and top of the head and white ventrally; anal fin colourless, or orange distally edged with black; base of each scale marked with a conspicuous black crescent.

For ecology see Green & Corbet in Trewavas, Green & Corbet, 1972.

Reasons for regarding *B. linnellii* as a synonym of *B. batesii* have been given already (Trewavas, 1962) and comparison of additional material from Barombi Mbo with the type of *B. batesii* and five other Kribi specimens confirms the synonymy. Three of the Kribi fishes are bigger than our biggest; in them the positive allometric trend of the snout and the negative one of the eye are continued to 42% and 16% respectively of the length of head. The interorbital width also rises to 39%. Two, of 268 and 314 mm SL, have the lower lip produced as a lobe.

The pharyngeal teeth of one Kribi specimen dissected for the purpose seem to be in process of replacement (or final shedding? No new teeth were found in the membrane), but teeth or seats on the bones were present for the usual formula, 2.3.5–5.3.2 and the shape was as in the Barombi Mbo specimens. In both this species and *B. mungoensis* the anterior tooth of the row of 5 is rather small, conical, the next stout with a point, the others sloping backwards with a posterior point and an anterior grinding surface. In the Kribi specimens the posterior barbel is 1·5 to twice the diameter of the eye, gill-rakers (2–3) + 1 + (9–12), dorsal iv 9 in all, the last simple ray 69–88·5% length of head, its rigid part 55·5–75·5%. Scales 26–28 : 4½ : 2–2½.

The higher lateral line counts suggest a population difference in this character, but a slight one (Table 5). Thys's counts (1967) from 8 specimens of Fernando-Poo nearly cover both ranges.

On the basis of Holly's descriptions (1927, 1929, 1930) neither Thys nor I can recognize names given by him to *Barbus* of Cameroun as synonyms of *B. batesii*. The nearest, as Thys remarks, is *B. versluysii* Holly, 1929, which has 4½ scales from dorsal to lateral line and fins of the right proportions; but Holly counts 29–30 scales in the lateral line and his figure (1930 pl. 1 fig. 8) shows this count to be made in the same way as ours; his description and figure of the lips suggest greater development than we find in such small specimens of our populations. Probably the posterior position of the pelvics shown in the figure (Holly, 1930 pl. 1 fig. 8) is a mistake since the description records them as under the first rays of the dorsal (as in *B. batesii*). If this is *B. batesii* it extends the distribution to the Bakoko highlands.

The only possible senior synonym of *B. batesii* is *B. compinei* Sauvage, 1879, of R. Ogowe, but a decision on this awaits further knowledge of the *Barbus* population of that river.

Blache et al. (1964) record three young from the Chad basin (Guelta de Tottous) as *B. batesii*, but from the data given they are more probably *B. foureaui* Pellegrin.

Steindachner (1914) recorded two species of *Barbus* from R. Ja, a secondary tributary of R. Congo rising near the sources of the rivers of southern Cameroun. One of them, which he identified as *B. mawambiensis* Steindachner (1911), seems more like *B. batesii* than *B. mawambiensis*, the type of which came from Ituri. The fauna of the Ja has much in common with that of the rivers of Cameroun, and it is quite possible that the distribution of *B. batesii* extends to it.

### *Barbus batesii* in Lake Soden

Fourteen specimens, SL 67·5–219·5 mm, were collected by Dr J. Griffith.

We include them in *B. batesii* while noting the following differences.

Although the scale-counts for the lateral line are the same (24 or 25, 27 in one) the range between the lateral line and the dorsal (3½–4½) is lower though overlapping; 5 of the 14 specimens have 3½.

In the size-range corresponding to the middle Mbo column of Table 4 (SL 117–219·5 mm) the length of head is 27·8–30·0% SL, longer than in Barombi Mbo but equal to that of the Nyoke specimens.

In the same size-range the length of the last simple dorsal ray is 20·5–23·2% SL, thus within the range for the corresponding Mbo fishes, but the rigid part is weaker and merges so imperceptibly into the flexible part that a separate measurement cannot be made of it. An attempt on some specimens gave 11·5–15·0% SL.

The problematic specimen recorded in 1962 from this region is clearly conspecific with these. The minute tubercles on the snout are present in the new specimens but also on some from Barombi Mbo.

### ***Barbus mungoensis*** n. sp.

HOLOTYPE AND PARATYPES. 18 specimens, 40·5–179 mm in SL, from R. Wowe, tributary of R. Mungo, coll. Dr Disney in October, 1970. BMNH 1973.5.14.163 (holotype, 179 mm), and BMNH 1973.5.14.164–182 (paratypes).

OTHER MATERIAL EXAMINED. 5, 30–38 mm SL, R. Blackwater, 1, 92 mm SL, R. Menge, and 2, 26 and 43 mm SL from R. Mungo between Baduma and Bolo, all coll. Dr Disney.

Scales 24–26 (28) : 4½ (5½) : 2. Dorsal iii–iv 8–9, usually iv 9. Gill-rakers on first arch (2–5) + (0–1) + (9–12). Pharyngeal teeth 2.3.5–5.3.2.

Proportions for three size-groups are set out in Table 5. The first and second columns correspond in size roughly to the second and third in Table 4 (*B. batesii*), the third is a younger size-group. Some features of the fry are compared with young *B. batesii* in Table 7 and Fig. 2. In the 26 mm fish from the Mungo the posterior barbel is already 0·8 diameter of eye and the upper caudal lobe 31% SL, but at this stage the last simple dorsal ray is no thicker than the following ray.

A specimen of 92·5 mm SL from R. Menge agrees better with this species than with *B. batesii*. It has a very long snout (42% length of head) and flexible, lobed lips. The flexible part of the dorsal spine is broken off and the rigid stump is only 22·4% SL, but it is thicker than in any *B. batesii* of comparable size. The posterior barbel is as long as the eye and the upper caudal lobe is 32% SL. It agrees in number of scales (24 : 4½ : 2) and gill-rakers (3 + 1 + 11) with both the Mungo *B. batesii* and *B. mungoensis*. The few fry from the Menge are probably *B. batesii* and the two species may exist together in this tributary.

TABLE 5

*Barbus mungoensis* from R. Wowe

| | | | |
|---|---|---|---|
| SL (mm) | 114·5–179 | 76–79·5 | 40·5–69·5 |
| *N* | 3 | 4 | 11 |
| Depth of body (% SL) | 28–29 | 27·5–30·5 | 28–31 |
| Length of head (% SL) | 25·4–26·8 | 27·5–31·6 | 29–31·5 |
| Last simple D ray | | | |
| (% SL) | 25·5–30·0 | 30·0–34·0 | 30·0–34·0 |
| (% length of head) | 100–111 | 106–120 | 91–114 |
| Rigid part of ray | | | |
| (% SL) | 24·5–28 | 26·6–30·2 | 26–30 |
| (% length of head) | 92–104 | 84–108 | 80–100 |
| Length of pectoral (% SL) | 21·0–23·8 | 22–25 | 22·5–23·5 |
| Length of anal (% SL) | 19–22 | 23–24 | – |
| Length of caudal lobe (% SL) | 27·3–31·4 | 31·2–33·8 | 31·5–36 |
| Snout (% head) | 35·8–37·6 | 29–39·5 | – |
| Eye (% head) | 24·8–28·4 | 30–32·5 | 29–36 |
| Interorbital width (% head) | 31–34 | 28–31·4 | – |
| Posterior barbel/eye | 1·3–1·5 | 0·86–1·1 | 0·8–1·2 |

TABLE 6

Scales in the lateral line in *Barbus batesii* and *B. mungoensis*

| | 24 | 25 | 26 | 27 | 28 |
|---|---|---|---|---|---|
| *B. batesii* | | | | | |
| R. Kribi | | | 1 | 2 | 3 |
| R. Nyoke | 3 | 1 | | | |
| Barombi-Mbo | 2 | 9 | 7 | 1 | |
| R. Kumba | 1 | 4 | 4 | | |
| *B. mungoensis* | | | | | |
| R. Wowe | 3 | 6 | 5 | | 1 |
| R. Blackwater | 2 | 2 | 1 | | |

TABLE 7

Contrasts in length of fins and barbels in fry of *Barbus batesii* and *B. mungoensis*

| | *B. batesii* (R. Kumba) | *B. mungoensis* (Wowe, Blackwater, Mungo) |
|---|---|---|
| SL (mm) | 27–53 | 26–56 |
| D ray (% SL) | 21–26 | 29–35 |
| C lobe (% SL) | 27–32 | 31–36 |
| Pectoral (% SL) | 17–21 | 21–23·5 |
| Posterior barbel (% eye) | 25–50 | 71–100 |

Life colours are not recorded. The fry sometimes have a dark spot at the caudal base and there may be irregular smudges on the body and caudal lobes.

RELATIONSHIPS. Although this population does not correspond exactly with descriptions of others it appears to be one of a series beginning with *B. habereri* (R. Ja) and continuing with *B. foureaui* into the Chad, Niger and Volta basins.

*B. habereri* Steindachner (1914 : 24 fig. 4 pl. iii fig. 1) agrees with it in scale-formula (25 : 4½ : 2½) and the well-developed lips, but has only one pair of barbels. Dr Kähsbauer has recently kindly confirmed this for me and gives the gill-raker count as 4 + 1 + 11. According to Steindachner's figure the rigid dorsal ray is 34·6% SL.

*B. brevispinis* Holly, 1927 (Rivers Lokundje and Sanaga, Cameroun) in spite of its name has a dorsal spine as long as in *B. mungoensis*, but has 30 scales in the lateral line series and 5½ between it and the origin of the dorsal.

Daget (1954 : 188), and following him Blache et al. (1964) and Daget & Iltis (1965), have used the name *B. occidentalis* Boulenger for the Chad and western populations, but the holotype of *B. occidentalis* has a short dorsal spine, its rigid part only three-quarters length of head. Until the Ogun population is studied I think it safer to use *B. foureaui* Pellegrin, 1919b (syn. *B. seguensis* Pellegrin, 1925) for these populations. They differ from the Mungo population in having usually 5½ scales between the dorsal and the lateral line, 12–16 gill-rakers on the lower part of the first arch and the lips more constantly lobed.

*B. lancrenonensis* Blache & Miton, 1960 (see also Blache et al. 1964 : 126, fig. 60) from R. Ngou, affluent of R. Mbere, Logone system, was described from three tiny specimens 14·7–33·5 mm long. The authors thought that it belonged to the section of *Barbus* containing small species with no enlarged dorsal ray and with radiately striate scales, but several features point to its being the young of *B. foureaui*. The radii of the scales were described as 'relativement nombreuses et faiblement convergentes'; dorsal iv 9; gill-rakers 10–11 on lower part of arch; a few lines of 'pores' on the head (as I have noted too in fry of the Mungo system); posterior barbel 0·6–1·0 diameter of eye. It is the similarity between these and our young *B. mungoensis* that drew my attention to them and leads me to suggest their identity with *B. foureaui*.

II. There are three species of *Barbus* with radiating striae on the scales and with the last simple dorsal ray flexible, not serrate.

### ***Barbus* (*Enteromius*) *callipterus*** Boulenger, 1907

Boulenger, 1907a : 486 (R. Kribi at Akok); id. 1911 : 167 fig. 145; Thys van den Audenaerde, 1967 : 48 fig. 15 (Fernando Poo).

For use of the subgenus *Enteromius* Cope, 1869, see Greenwood (1970), who shows that the name should replace *Beirabarbus*.

This species was caught in R. Mungo between Baduma and Bolo, in the Mungo tributaries Wowe and Menge and was the only small *Barbus* caught by us in the Kotto area, being taken in the lake itself, in Tung Nsuia, a stream entering it from the crater rim, and in the outflowing stream Nganjoke.

All Kotto specimens had the characteristic black patch on the dorsal fin leaving the tip of the fin pigment-free. In life the proximal part of this fin varies from pale yellow or salmon pink to orange and the caudal fin from pale yellow to orange-red. In a well-coloured fish the top of the iris is red. In all, the head is brassy yellow.

Already at 14–18 mm SL these colours are developed though still at the pale end of the range.

In samples from the Mungo and its tributaries, where it was abundant, the black pigment on the dorsal fin is much less intense, often faint, less sharply demarcated than in the Kotto samples or the types, and may extend nearly to the end of the first three branched rays.

No significant differences in numbers of scales, fin rays and gill rakers could be found between the two populations and the pharyngeal teeth are alike.

Comparison in proportions between Kotto and Mungo samples is blurred because in the preserved material all Kotto specimens (except the two juveniles) are bigger than all Mungo specimens. The four syntypes of *B. callipterus* are also smaller than the Kotto specimens, so that when, as with length of head and diameter of eye, the Mungo specimens are more like the types the difference between both and the Kotto fishes can be ascribed to allometry. Only in the height of the dorsal fin is the Mungo sample possibly peculiar. This ratio is :

in 8 specimens of 64·7–73·5 mm SL from Kotto 24·0–29·6% SL
in 4 syntypes of 50·5–63·5 mm SL from Kribi 27·2–29·9% SL
in 8 specimens of 48·7–59·5 mm SL from R. Blackwater 28·5–32·3% SL

When allowance is made for individual variation and negative allometry even this may not be significant.

Thus the question is left open whether the different pigmentation of the dorsal fin in the Mungo and Kotto populations is environmentally controlled or indicates a genetic relationship of the respective populations with others showing the same characteristic.

I have discussed this with Mr A. Indrasenan, who has the same problem in Northern Nigeria. We have both examined the syntypes of *B. deserti* Pellegrin, 1909, in Paris and London. As the Hopsons noted (1965 : 113) these all have the dorsal fin damaged at the tip. In the least damaged Mr Indrasenan and I found some indication of dorsal fin pigmentation more like that of the Mungo samples than the types of *B. callipterus* and if there are two species involved it is possible that the Mungo population should be linked with *B. deserti*. The type locality of the latter is in the Algerian Sahara, but populations showing one or the other type of pigmentation are found in several places between this and Cameroun.

ECOLOGY. See Corbet et al. 1973. In Lake Kotto the food consists mainly of bottom-living invertebrates, with chironomid larvae predominating.

MATERIAL preserved in 1970

| BMNH register no. | SL (mm) | Locality | Collector |
|---|---|---|---|
| 1973.5.14.42–44 | 14–18 | R. Nganjoke | J. Green and S. A. Corbet |
| 1973.5.14.73–81 | 64–72 | Barombi Kotto | J. Green and S. A. Corbet |
| 1973.5.14.114 | 44·5 | R. Wowe | R. H. L. Disney |
| 1973.5.14.45–49 | 37–44 | R. Mungo between Baduma and Bolo | R. H. L. Disney |

| BMNH register no. | SL (mm) | Locality | Collector |
|---|---|---|---|
| 1973.5.14.50–72, 82–85 | 26–56 | R. Menge | R. H. L. Disney |
| 1973.5.14.86–110 | 40–59 | R. Blackwater | R. H. L. Disney |
| 1973.5.14.111–113 | 40–43 | R. Mungo at bridge near Etam | R. H. L. Disney |

### ***Barbus camptacanthus*** Boulenger, 1911

Fig. 3

*Puntius* (*Barbodes*) *camptacanthus* Bleeker, 1863 : 111 pl. xxiii fig. 2 (Fernando Poo).
*Barbus camptacanthus* ; Boulenger, 1911 : 166 fig. 144 ; Thys van den Audenaerde, 1967 : 40 fig. 13.

This fish was abundant in the Mungo tributaries and in R. Bille (Meme system), but we did not find it in the Kotto area.

The pigment pattern in adults is as shown in the figures of Boulenger and Thys, with a black line along the middle of the flank swollen into an elongate patch on the caudal peduncle and another from below the origin of the dorsal fin forwards, not reaching the operculum. As Thys notes, there is variation in the shape of the anterior patch ; in young this is not elongate but rounded and from it a fainter pigment streak extends vertically upwards to the base of the first dorsal rays (Fig. 3). The fins are all coloured from yellow to red according to the density of the chromatophores. There is no golden sheen on head or flanks.

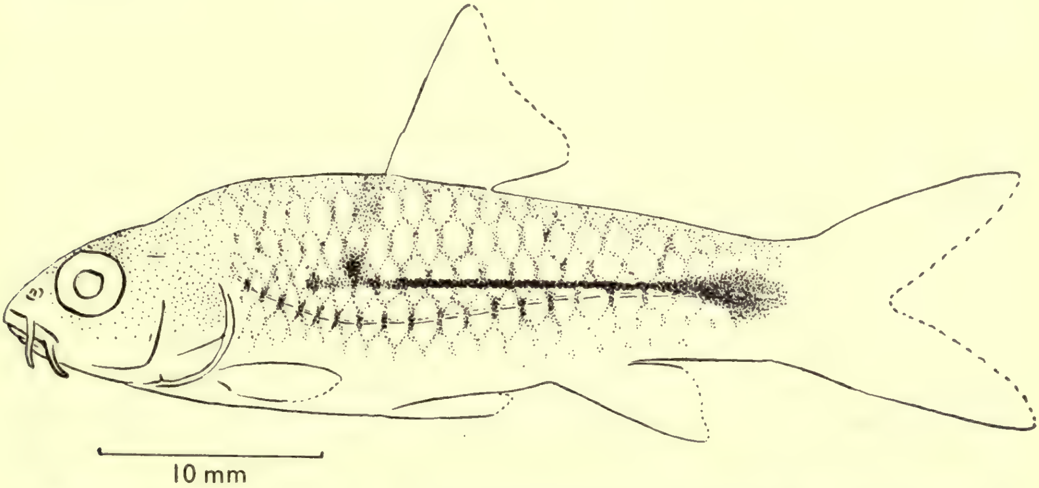

FIG. 3. *Barbus camptacanthus*. Outline drawing of young to show the melanin pattern.

In some older specimens from Fernando Poo and the mainland the anterior blotch ceases to become a conspicuous part of the pattern and shrinks or is obscured by the general darker colour. Markings at the bases of the anterior scales of the lateral line may be more prominent than the mid-lateral streak. In Bleeker's figure of an adult of about 100–130 mm the lateral streak is intensified at anterior and posterior ends and faint horizontal lines mark the scale-rows above it.

Boulenger (1911 : 166) and Thys (1967) noted the presence of 'nuptial tubercles.' These or their crater-like seats are present in most adults of both sexes on the preorbital (lacrimal) and first infraorbital bones, sometimes also on the second, and have sharp points directed slightly backwards. In our material they are already present at SL 66·5 mm, rudimentary at 61·5 mm and absent in smaller fishes, but in a sample from Lomée district they are present at 54 mm.

Specimens in the BMNH range to SL 130 mm, but ours were all young. Possibly the swift waters in which our collections were made are less favoured by adults except for breeding.

Thys (loc. cit.) has discussed the distribution of *B. camptacanthus*. It is abundant throughout the forested region of Cameroun and Gabon and is found southwards to the Congo and westwards into the Niger delta.

MATERIAL collected in 1970

| BMNH register no. | SL (mm) | Locality | Collector |
|---|---|---|---|
| 1973.5.14.128 | 66·5 | R. Bille | R. H. L. Disney |
| 1973.5.14.115–119 | 25–52 | R. Wowe | R. H. L. Disney |
| 1973.5.14.120–126, 130–159 | 23–61·5 | R. Menge | R. H. L. Disney |
| 1973.5.14.160–162 | 16·5, 19·5 and 41·5 | R. Moliba | R. H. L. Disney |
| 1973.5.14.127 | 60 | R. Kumba at Buea Road Bridge | R. H. L. Disney |
| 1973.5.14.129 | 44 | R. Kobe at Etam | R. H. L. Disney |

## ***Barbus thysi*** n. sp.

*Barbus trispilos* (nec Bleeker) ; Thys van den Audenaerde, 1967 : 44 fig. 14 (Fernando Poo).

HOLOTYPE. 53 mm SL from R. Kake, at Kake village, Mungo system, BMNH 1973.5.14.284.

PARATYPES. 10, 31–63·5 mm SL from R. Blackwater, Mungo system, BMNH 1973.5.14.204–213.

Named for Dr D. Thys van den Audenaerde, who collected this species in Fernando Poo and recorded the difference in colour pattern between it and *B. trispilos*.

DESCRIPTION. Based on 28 specimens from the Mungo system, including the holotype and paratypes, and one from R. Bille, Meme system. For some details further specimens from the Mungo samples are used.

Depth of body 26–33% SL, length of head 24·5–30 (33·3 at 22 mm SL). Distance between snout and origin of dorsal fin 46·5–51·5%. Diameter of eye 27–36% length of head.

Anterior barbel at standard lengths below 30 mm just reaching anterior edge of eye, but at SL over 30 mm reaching beyond middle of eye, usually to posterior edge or beyond, in two specimens to posterior end of operculum ; its length 1·05–3·1 times diameter of eye, 30–93% length of head, 9·7–23·5% SL. Posterior barbel in adults usually extending to preoperculum or beyond, in a specimen of 63·5 mm well beyond posterior edge of operculum ; 1·3–3·6 times diameter of eye, 43–103% length of head, 9·6–26·0% SL (see also Table 8).

Gill-rakers on outer side of first arch (0–2) + (0–1) + (4 or 5). Pharyngeal teeth 2.3.5–5.3.2.

Scales 25–28 in lateral line, excluding 1 or 2 on base of caudal fin (26–30 including these) ; 4½ from lateral line to dorsum in front of dorsal fin, 2, 2½ or 3 between lateral line and pelvic fin.

Dorsal iii 8 (iii 9 in one). Anal iii 5.

*Colour.* Countershaded from grey-brown on the back to white on the belly with metallic brassy colour on operculum and flanks contrasting handsomely with the black pigment. Usually three conspicuous black spots on each side at the level of the horizontal myoseptum, the middle largest and most intense, the caudal well marked and the anterior variable, smaller and often fainter than the others, occasionally absent. Some part of the middle spot below last dorsal ray. Distance between middle of first spot and middle of second contained 1·36–2·0 times in distance between middle of second and middle of caudal spot, rarely (in only 2 of 35 measured) less than 1·4. Lateral line scales often each with a vertical black mark at its base ; similar markings on the anterior scales of the row below and on the scales of a variable number of rows above until they merge in the general dark colour of the back. Often a small dark spot at origin of dorsal and occasionally, especially in young, a pigment patch above origin of anterior anal rays. Fins usually colourless, but caudal sometimes yellow or pinkish at base. In formalin-fixed specimens a subcutaneous grey band extends between caudal and middle spots.

The intensity of the markings varies with the locality, the sample from R. Kumba below the pollution of the town being the most dingy.

*Variation in the barbels.* The wide ranges in barbel lengths are partly due to individual variation and partly to a positive allometric trend, even between standard lengths of 30 and 65 mm (much steeper at smaller sizes). As well as a broad allometric band there are exceptional individuals and subpopulations with higher or lower averages. Examples of the former are one of 31 mm SL from the Blackwater with barbels of 19·6 and 19·8% SL, ratios not matched in any other of less than 57 mm except another individual, the holotype, of 53 mm (R. Kake) in which the anterior is 23%, the posterior 19·8% SL. But the Blackwater ratios include other high ones, four fishes of 58–65 mm having anterior barbels measuring more than 20% SL, whereas our only other Kake individual is average for its size. In Mpanga Water and R. Kumba below the town, on the other hand, barbel lengths are below average.

The six specimens from 'British Cameroons', probably from the coastal area, 38–65 mm in SL, have rather short barbels, the anterior 7·5–10·5% SL, the posterior 9·6–13·0%, and the barbels measured by Thys (1967) in the Fernando Poo specimens are in the lower part of our ranges (maximum 52·6% length of head).

In short, although this is a long-barbelled species several factors combine to produce a wide range of variation in this character and little taxonomic value can be attached to local differences in the average lengths. Nevertheless, the longest barbels were found in specimens of 50–70 mm SL from swift, clear streams and this may prove to have some ecological significance.

*The species in Fernando Poo.* Thys's description (1967) includes some with slightly deeper body and slightly shorter head and at least one with 5½ rows of scales above the lateral line, but clearly refers to the same species as that of the mainland. Its removal from *B. trispilos* removes also the difficulty he found in explaining its geographical distribution.

*Young.* Four young of 9·5–11·5 mm SL were taken in R. Blackwater. The squamation is not complete but they have a strong spot at the end of the caudal peduncle. This excludes *B. callipterus* and since *B. camptacanthus* was not caught by us in the Blackwater they probably belong to *B. thysi.* There is no sign of barbels at 9·5 mm and at 11·5 they are mere stumps. Of the lateral spots only the caudal is present, but it is strong ; a thin black line, composed of both superficial and deep melanophores, extends from this forwards to below origin of dorsal fin. There is some pigment on the head and back, a strip mid-ventrally in front of the pelvics and a pair of ventrolateral strips behind the pelvics.

In a 22 mm specimen from R. Kumba at Buea Road Bridge the anterior barbel barely reaches the eye and the posterior is still shorter ; the caudal spot is strong, the middle spot very small and the first has not yet appeared. In one of 29 mm from the same batch both pairs of barbels are present, but short, each about 2 mm long. There is still only one black spot, the caudal, but there is a little pigment in the position of the future middle spot. The subcutaneous streak is well marked. In this locality the pigment spots are weak in adults so their poor development in the 29 mm specimen may not be typical of the species.

DISTRIBUTION. *B. thysi* is known with certainty only in the Mungo, Meme, the short rivers between their mouths and Fernando Poo, but a record by Radda (1971a : 84) of '*Barbus trispilus*' from R. Lobé, South Cameroun, probably indicates that it lives in other Camerounian rivers. Roman (1971) does not record it from Rio Muni.

AFFINITIES. Comparison with *B. trispilos* and *B. sublineatus.*

*B. thysi* resembles *B. trispilos* Bleeker (1863) in numbers of scales and fin-rays, in the well-developed barbels and the presence of three distinct black spots on each side. It resembles also *B. sublineatus* Daget (1954) in these features, but the latter nearly always has additional spots between the second and caudal spots, and all the marks are more elongate than in *B. trispilos* and *B. thysi.* The second spot of *B. sublineatus* is, however, in the same position as that of *B. thysi*, whereas that of *B. trispilos* is more posteriorly placed, usually wholly behind the last dorsal ray, a difference noted by Thys in 1967.

If the distance between the centres of the first two spots be denoted by *a*, that between the centres of the second and caudal spots by *b*, then a comparison of the three species gives :

|  | *B. trispilos* | *B. sublineatus* | *B. thysi* |
|---|---|---|---|
|  | $N = 31$ | $N = 15$ | $N = 35$ |
| $b/a$ | 1·02–1·37 (1·4) | 1·4–2·25 | 1·36–2·0 |
| Mean | 1·18 | 1·73 | 1·62 |

Daget & Iltis describe (1965) variation in the position of the spots in *B. trispilos* from Ivory Coast, but in the variants from the typical condition the middle spot is more posterior and thus the difference from *B. thysi* is exaggerated.

A further difference between *B. trispilos* and *B. thysi* is in the colour pattern of the young. In a formalin-fixed specimen of 18·5 mm SL from R. Wei Wei (Ghana) all three pigment spots are present on each side, there is a strong spot at the origin of both dorsal and anal fins and no subcutaneous lateral streak ; the barbels are each about 2 mm long. At 26·3 mm the pigment pattern is the same and the barbels are respectively 3·5 and 3·8 mm long. Thus from our admittedly inadequate numbers of young it seems that both adult pigment pattern and barbels develop earlier than in *B. thysi*.

In two young *B. sublineatus* of 26 and 28 mm SL four lateral spots are present and there is a strong anal spot ; the barbels at SL 28 mm are shorter than in *B. trispilos* of 26·3 mm.

In comparing lengths of barbels it must be taken into account that the Hopsons' (1965) measurements are shorter than my own (see Table 8). In their paper of 1965 they tabulate measurements for 24 specimens of each species. For comparison I give in Table 8 my own measurements for smaller samples of *B. trispilos* and *B. sublineatus*, in the case of the former from the Hopsons' material (though not necessarily the specimens used for measuring), in the latter from the Cross River sample mentioned below. The lower minimum ratio in the Hopsons' figures may be the result of including smaller specimens in which the definitive length of the barbels had not been attained. Ranges and means in *B. thysi* are raised by the inclusion of two specimens respectively from the Kake and Blackwater in which both barbels are 20% SL or over, but in 11 of the 26 *B. thysi* measured the anterior barbel is over 15% and in 11 the posterior is 17% or over.

Finally, although the length of barbels is too variable to be used as a diagnostic character between *B. thysi* and *B. trispilos* the evidence suggests that they may grow longer in *B. thysi* and they are definitely longer in both than in *B. sublineatus* and *B. perince* Rüppell. The last named invites comparison because, although in the Nile its scale count is higher than in *B. thysi* in the Chad basin and at Panyam the lateral line count may be the same (but usually there are 5½ D–l.l.).

Table 8

Length of barbels as % SL in three species of *Barbus* as measured by the Hopsons (1965 : 127 and 129) and by the author

| | *B. trispilos* | | *B. sublineatus* | | *B. thysi* |
|---|---|---|---|---|---|
| | E. T. | Hopson | E. T. | Hopson | |
| SL | 38·5–61 | 27–65 | 39·5–57 | 28–40 | 31–68·5 |
| *N* | 8 | 24 | 9 | 24 | 26 |
| Anterior | 10·25–15·5 | 9·8–12·7 | 8·7–10·6 | 5·3–9·1 | 10·3–23·6 |
| Mean | 12·2 | 11·1 | 10·2 | 7·3 | 14·8 |
| Posterior | 13·8–16·9 | 11·7–15·4 | 10·1–14·5 | 7·8–11·2 | 10·9–26·0 |
| Mean | 15·1 | 13·8 | 12·3 | 9·2 | 16·1 |

### Distribution of *B. trispilos*

The type locality, 'Dabo Krom, Guinée', is in southern Ghana ; most of Bleeker's West African material was sent by Pel, then Resident at Cape Coast Castle. Mr S. A. Whyte tells me that 'krom' is a suffix meaning 'town' and that Dabo Krom is a small town not far west of Accra. The species is not reliably recorded east of Ghana and the Hopsons did not even find it in the Volta. They accepted Norman's (1932) record from Sierra Leone, but I find that the specimens on which this was based are *B. eburneensis* Poll, 1941, exhibiting the four lateral spots, broad infraorbital bones and short barbels of that species. The Hopsons ignored the Nigerian records in Boulenger's list of 1916 (p. 267) repeated by Trewavas & Irvine in Irvine et al. (1947). I have re-examined the two samples on which these records were based ; neither is *B. trispilos*.

One of them is listed by Boulenger (loc. cit.) as specimens 16–27 of *B. trispilos*, collected at Omalu, headwaters of R. Aboina, Cross River system, by Major G. E. Bruce and registered as BM (NH) 1911.3.30.33–42. So from the catalogue list and the register we should expect to find 10 specimens in the jar. In fact I found 12 ; 2 of them were *B. trispilos* and 10 were *B. sublineatus* Daget, 1954. I suspect that the two *B. trispilos* had been put in this jar by mistake at some time when the ten *B. sublineatus* were being compared with specimens from Ghana. This uncertainty disqualifies them as evidence that *B. trispilos* occurs east of Ghana.

The distribution of *B. sublineatus* is typically in the savannah region of Ivory Coast and Ghana and in the upper and middle Niger ; the above record extends it to the headwaters of the Cross system. Daget & Stauch (1963 : 92) do not record it from the tributaries of the Benue, but they suggest that *B. chlorotaenia* Boulenger, which they do record, may be identical with *B. sublineatus* and its name a senior synonym. I am not convinced that this is so. The specimens of '*B. chlorotaenia*' from Ejura, Ghana, so recorded by Trewavas & Irvine in Irvine et al. (1947) are *B. sublineatus*, but I would now hesitate to regard them as conspecific with the types of *B. chlorotaenia* until more is known of the population of the type locality of the latter, R. Omi, east of Lagos. The lateral band in the types is more uniform than any described for *B. sublineatus* and life colours as described are rather different.

The other Nigerian sample listed as *B. trispilos* comprises four specimens of *Barbus liberiensis* Steindachner, 1894, measuring 27·0–38·5 mm SL. They were presented by J. P. Arnold in 1913 and said to be from Sapelle, Niger delta. This species, first described as a 'variety' of *B. camptacanthus*, was synonymized by Boulenger with *B. trispilos*, but Greenwood (1962) redescribed the types and showed that they, together with some specimens from Sierra Leone, belong to a distinct species. I think it possible that some of the specimens from Ivory Coast assigned by Daget & Iltis (1965) to *B. trispilos* may also be *B. liberiensis*. The young specimens from Sapelle agree with this species in numbers of scales – 22 + 1 or 2 in the lateral line, 3½ from lateral line to origin of dorsal fin – in the characteristic decurved profile and the pattern of three large round spots on the flanks and a black leading edge to the dorsal fin. There is no black spot at the origin of the anal fin, also in agreement with the western samples. The barbels (anterior 6·5–9·2% SL, posterior 10·3–11·4%) are relatively a little shorter than in Greenwood's specimens, which were all much bigger. The lateral spots in *B. liberiensis* are nearly equidistant. Using the same formula as on p. 352, in the five Sierra Leone specimens $b/a = 1{\cdot}05-1{\cdot}2$, in those from 'Sapelle' $b/a = 1{\cdot}0$ or the middle spot is marginally nearer to the caudal than to the anterior.

Greenwood, like Steindachner, noticed the resemblances between this species and *B. camptacanthus*. I think it is even closer to *B. eburneensis*, having also a rather broad infraorbital bone in the adult.

A record from the Niger delta is even more surprising for *B. liberiensis* than it would be for *B. trispilos* and this one should be treated with the caution necessary for aquarists' material Although Arnold himself was very careful some of his suppliers may have been less meticulous.

### Comparison with other species

I have considered as possible relatives of *B. thysi* also *B. lepidus* Pfaff of the upper and middle Niger and the Chad basin, a species that Daget (1954) distinguishes from *B. sublineatus* by the absence at all ages of an anal spot. Its pattern of lateral spots is different too from both *B. sublineatus* and *B. thysi* but, as in the latter, in the very young there is a caudal spot and a narrow streak running forwards from it. It has shorter barbels than *B. thysi*. *Barbus tetrastigma* Boulenger (1913) of the northern tributaries of the Congo has an additional lateral spot and the anterior spot is well above the lateral line instead of impinging upon it as in *B. thysi*.

Although in the Mungo and Meme systems and Fernando Poo *B. thysi* is not accompanied by either of these related species and can therefore be said to represent them geographically, there does not seem to be enough evidence to consider it a subspecies of one of them rather than another and for this reason I propose specific rank for it.

MATERIAL EXAMINED

| BMNH register no. | SL (mm) | Locality | Collector |
|---|---|---|---|
| 1973.5.14.284 holotype | 53 | R. Kake, Mungo system | R. H. L. Disney |
| 1973.5.14.204–213 paratypes | 31–63·5 | R. Blackwater | R. H. L. Disney |
| 1973.5.14.258–283 | 37–57 and 9·5–11·5 | R. Blackwater | R. H. L. Disney |
| 1973.5.14.202 | 49 | R. Kake | R. H. L. Disney |
| 1973.5.14.214–240 | 28·5–58·5 | R. Mungo between Baduma and Bolo | R. H. L. Disney |
| 1973.5.14.305–321 | 22·5–58 | R. Kumba at Buea Road Bridge | R. H. L. Disney |
| 1973.5.14.285–290 | 38–56 | R. Kumba above waterfall | R. H. L. Disney |
| 1973.5.14.291–304 | 41–48·5 | Mpanga Water, tributary of R. Kumba | R. H. L. Disney |

| BMNH register no. | SL (mm) | Locality | Collector |
|---|---|---|---|
| 1973.5.14.192–201 | 37–63·5 | R. Mungo at bridge near Etam | R. H. L. Disney |
| 1973.5.14.241–257 | 47·5–68 | R. Wowe | R. H. L. Disney |
| 1973.5.14.203 | 48 | R. Bille, Meme system | R. H. L. Disney |
| 1952.8.30.2–5 | 38–54·5 | British Cameroons | Deveson |
| 1937.11.24.2–3 | 57·5, 65 | British Cameroons | E. Roloff |

### Synonyms of *Barbus baudoni* Boulenger, 1918

In the course of these determinations I had occasion to look again at the syntypes of *B. baudoni*. As Blache et al. (1964 : 126) have pointed out, Boulenger was mistaken not only in stating that the types lacked barbels (they are very short), but also in giving the number of scales around the caudal peduncle as 8 instead of 12. This removes the only distinction between *B. baudoni* and *B. svenssoni* Johnels, 1954, and also between both and *B. voltae* Hopson, 1965. *B. baudoni* therefore, or *B. baudoni* with its close relatives, has a wide distribution in the savannah zone from R. Shari, through the Lake Chad area, the upper tributaries of the Benue (Daget & Stauch, 1963 : 92), in the upper Volta and the Gambia.

## CLARIIDAE

*Clarias walkeri* Günther was the only species caught in the rivers and in Barombi Kotto and was present in the basin of Barombi Mbo together with *C. maclareni* (see Trewavas et al. 1972).

The *Clarias* of Lake Soden, recorded from one specimen by me in 1962, as from the neighbouring village of Lisoni, will be described from further specimens by Dr J. Griffith.

## BAGRIDAE

### *AUCHENOGLANIS* Günther, 1865

### ***Auchenoglanis ahli*** Holly, 1930

Holly, 1930 : 201 pl. 1 fig. 9 ; Trewavas, 1962 : 155 fig. 1.

Three specimens 93.5, 125 and 132 mm SL from R. Nganjoke (BMNH 1973.5.14. 327–329) and three of about the same size range from R. Nyoke (two had their caudal ends bitten off by an unknown predator) (BMNH 1973.5.14.330–1 and 333) ; one of SL 117·5 mm from R. Mungo at the bridge near Etam (BMNH 1973.5.14.332).

These belong to the section of the genus in which the interneural plate in front of the dorsal fin is narrow, hidden beneath the skin and not meeting the occipital process. The pectoral spine is coarsely serrate on its posterior edge.

In the following description figures for the Mungo specimen are given separately in brackets and Table 9 shows the length of barbels in the same two groups in comparison with Holly's data for *A. ahli* and *A. pietschmanni*.

Depth of body 18–20·5 (20)% SL, length of head 32·5–34·5 (32)%, 1·40–1·45 (1·5) times its width. Diameter of eye 11–13 (14·5)% length of head, interocular width 25·4–28·8 (28·3). Premaxillary tooth band 2·5–4 times as long (from left to right) as wide.

Dorsal spine, including its flexible tip, 14·4–16·6 (15·3)% SL, 43–50 (48)% length of head. Pectoral spine, excluding its flexible tip, 17–19 (17)% SL, 49·5–56·0 (53·5)% length of head. Soft dorsal rays 7 (f.5 and Mungo specimen) or 8 (f.1). Anal 9–10 (11), the first 2 or 3 simple. Caudal fin rounded.

Gill-rakers (2–3)+1+7 (2+1+7) on the first arch.

Specimens from the streams near Kotto, like the types of *A. pietschmanni* and *A. ahli*, have on the body numerous dark spots about the size of the eye with cloudy edges and (like *A. ahli*) similarly vague-edged vertical bars on the flanks; the fins are spotted. The Mungo specimen has smaller and fewer spots and the vertical bars are narrower.

I have placed these specimens in *A. ahli* rather than in *A. pietschmanni* Holly (1926 : 158 and 1927b : 208 fig. 3) because they agree with the former in the number of anal rays (13–14 in *A. pietschmanni*). Holly distinguished *A. ahli* especially by the longer barbels, but the types of this species were much smaller than those of *A. pietschmanni* and the difference in relative barbel length is in accordance with a usual allometry in catfishes. Our Mungo specimen fits quite well into a series including both (Table 9), those from the neighbourhood of Kotto not so well. The types of *A. pietschmanni* were from *R. Mbam*, those of *A. ahli* from the Bakoko Highlands.

TABLE 9

*Auchenoglanis*. Length of barbels as % length of head and numbers of anal rays*

| | Mungo | Nyoke and Nganjoke | | *A. ahli* | *A. pietschmanni* |
|---|---|---|---|---|---|
| | | (1970) | (1962) | from Holly | |
| *N* | 1 | 6 | 1 | 6 | 5 |
| SL (mm) | 117·5 | 93·5–132 | 77·5 | 67–105 | 249–317 |
| Barbels | | | | | |
| Maxillary | 65·0 | 43·8–62·0 | 76·5 | 87–100 | 48·7–66·3 |
| Outer mandibular | 112·5 | 72·0–94·0 | 115·0 | 122–137 | 98·5–103·0 |
| Inner mandibular | 57·3 | 42·0–52·7 | 55·3 | 39–43 | 41·0–51·0 |
| Anal rays | 11 | 9–10 | 10 | 10–11 | 13–14 |

* For the types of *A. ahli* Holly's ratios have been converted to % and for *A. pietschmanni* his measurements in mm have been similarly converted.

Whether *A. pietschmanni* and *A. ahli* are distinct, whether we have one or two species in the Mungo and Meme systems and the relationship of these to Holly's species can be decided only after study of the variation, individual or allometric, within the populations in the characters indicated in the table and in colour pattern. Together the specimens concerned represent closely related populations.

In the same area (Bakoko Highlands) Holly has recorded *A. ballayi* Sauvage. This species of the northern tributaries of the Congo and R. Nyong is distinguished from the group to which our samples belong by the smaller, kidney-shaped patch of premaxillary teeth and the weakly serrate pectoral spine (see Trewavas, 1962). *A. monkei* Keilhack (1910), from the delta of R. Wouri, differs in having the occipital process meeting the interneural plate, and its premaxillary tooth-band was described as small and kidney-shaped, twice (adult) or three times (young) as long as wide.

## MOCHOKIDAE

### *CHILOGLANIS* Peters, 1868

The species of *Chiloglanis* are small catfishes that live under stones in clear running water. The ventral mouth is surrounded by a sucking disc that forms a large part of the ventral surface of the head and incorporates the bases of the barbels ; its lower surface is patterned with bosses of thickened epithelium set with taste buds. The eyes and two pairs of nostrils are dorsal.

The mandibular teeth are S-shaped like those of *Synodontis* (see Poll, 1971), grouped together in one or two rows in the middle of the jaw. The second row when present is probably a replacement row. The teeth of the upper jaw, also S-shaped, are borne on the premaxillae and, some, in the membrane immediately behind the premaxillary symphysis.

### Structure of the mouth and disc

I have studied this by means of a dissection of a *C. batesii* Boulenger from South Cameroun, an alizarin preparation of *C. micropogon*, longitudinal and transverse sections of two young specimens probably of *C. micropogon* and sections of part of the disc of an older *C. micropogon*.

The bones of the jaws and ethmoid region are similar to those of *Atopochilus guentheri* Schilthuis as figured by Starks (1926, fig. 15), the maxilla being rather well developed, lying dorsally to the premaxilla and articulating with the short palatine. The A1 section of the adductor mandibulae has a musculous insertion on it and to its distal end is attached the core of the maxillary barbel. The maxilla and its muscle probably constitute the main agent controlling the suction of the disc. The premaxilla is shaped like a rigid lobster claw or a wishbone, with the stem of the claw towards the midline, where its dorsal surface bears an apophysis for articulating with the ethmoid. At the symphysis right and left bones are separated by a fibrous pad. The anterior limb of the claw is curved with its concave surface behind and grooved. Attached to the groove and in the tissue behind are two to five uneven rows of relatively large S-shaped teeth. Only the small end of the S projects through the membrane of the disc with a brown, pointed or chisel-shaped tip.

Behind these teeth is the posterior, straight limb of the premaxilla and this bears on its posterior mediad surface some much smaller teeth, shaped as a more gently curved S with their tips pointed backwards into the mouth. The lateral of these are attached to the bone, but others are quite free from it in the membrane between right and left bones. In *C. batesii* the attached and free teeth compose a uniform group, but in *C. micropogon* the median teeth are still smaller and sections show that

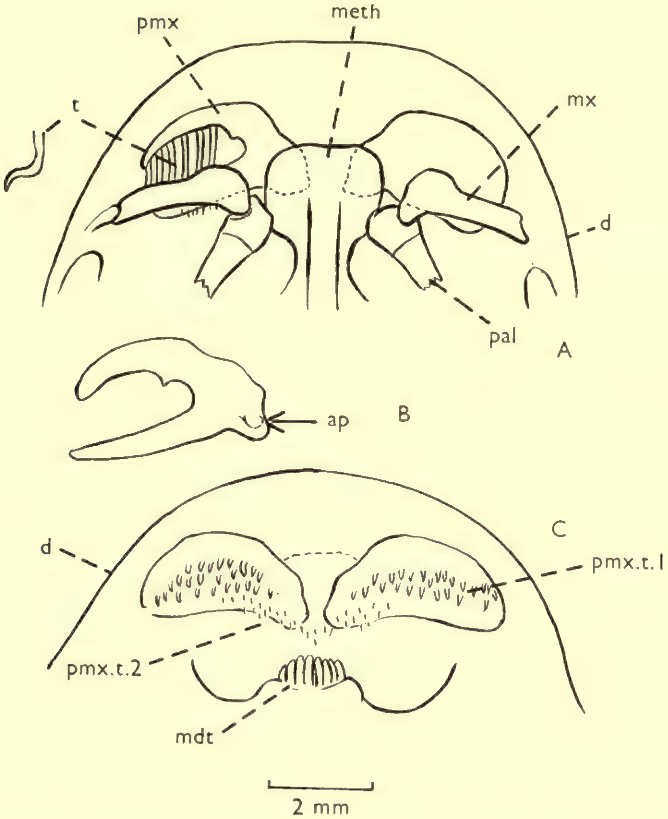

FIG. 4. *Chiloglanis batesii*, specimen from R. Ja. A. Dorsal view of bones of anterior part of head, with premaxillary teeth indicated on left. B. Isolated premaxilla. C. Outlines of tooth patches from below. *ap* = apophysis for ethmoid, *d* = edge of disc, *md.t.* = mandibular teeth, *meth* = mesethmoid, *mx* = maxilla, *pal* = palatine, *pmx* = premaxilla, *t* = isolated premaxillary tooth and bases of some *in situ*, *pmx.t.*1 = main patch of premaxillary teeth, *pmx.t.*2 = patch of smaller premaxillary teeth.

the membrane in which they lie forms a minute pouch opening backwards, the teeth at the edge of the pouch forming a transverse series across the midline. Examined with a dissecting microscope these latter appear as a row of minute ciliiform teeth on a small membranous curtain. This pouch is not the oral valve, which is a more posterior, wider, thin-walled pouch.

Boulenger (1907b) and Whitehead (1958) refer to these smaller premaxillary teeth as vomerine, but, as we have seen, the lateral ones are attached to the premaxilla and although the anterior end of the vomer is above the median teeth it is separated from them by connective tissue ; their position in front of the oral valve also shows them to belong to the premaxillary series.

Fig. 4 shows these structures in a dissected *C. batesii* and Fig. 5 in an alizarin preparation of a smaller *C. micropogon*. The teeth have been omitted from Fig. 5, but supporting structures of the disc, not obvious in dissection, have taken the stain

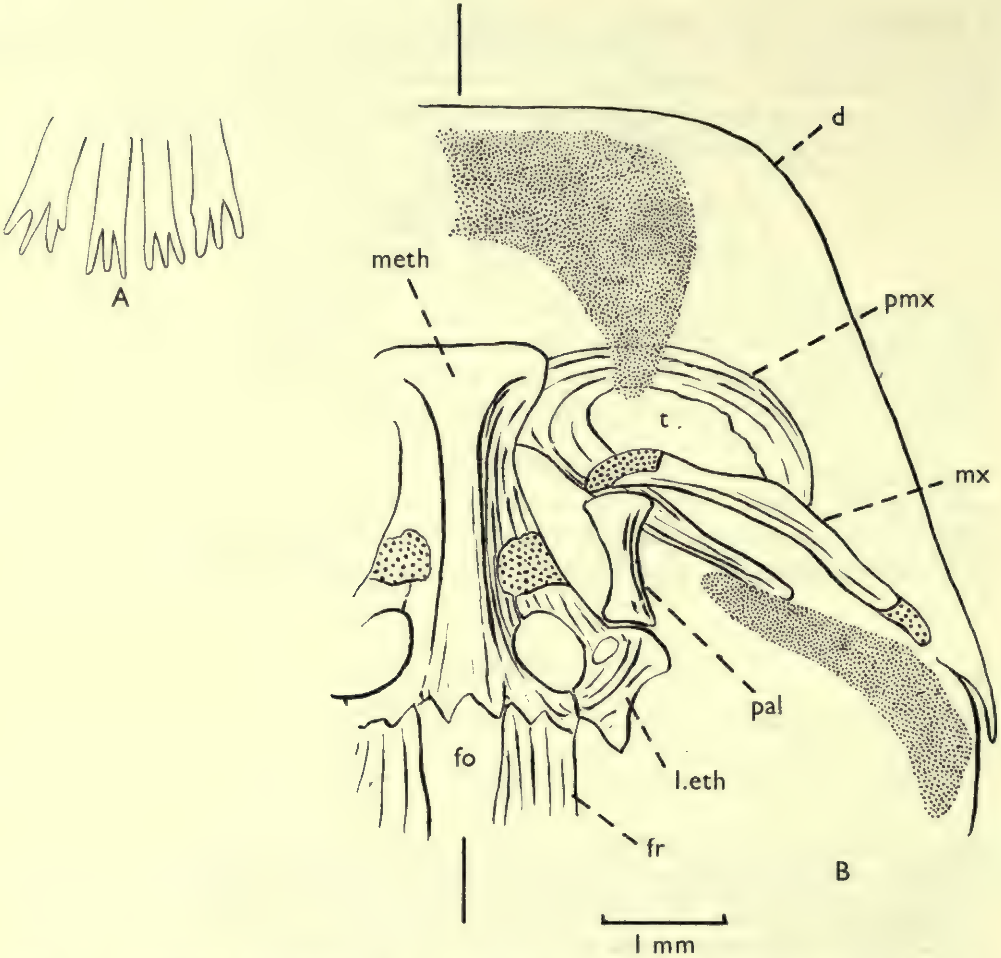

FIG. 5. *Chiloglanis micropogon*. A. Cartilaginous supports of posterior part of disc. B. Right half of skeletal tissues of anterior part of head. Coarse stipple hyaline cartilage, fine stipple fibrocartilage. *d* = edge of disc, *fo* = frontal fontanelle, *fr* = frontal, *l.eth* = lateral ethmoid, *meth* = mesethmoid, *mx* = maxilla, *pal* = palatine, *pmx* = premaxilla, *t* = space between arms of premaxilla where the main premaxillary teeth are situated.

with a purplish colour and are inserted. Sections show them to be composed of fibrocartilage. One extends from above the anterior limb of the premaxilla on each side forwards, and near the anterior rim of the disc bends towards the midline, where it is continuous with its counterpart of the other side, the whole recalling the front bumper of a car. Over it lies a median pad of less collaginous tissue. Another is attached to the posterior limb of the premaxilla and is directed obliquely outwards behind the maxilla and parallel to it. In the part of the disc representing the lower lip are two pairs of bars composed of fibrocartilage incorporating a narrow rod of hyaline cartilage. Each is divided at its distal end in a palmate manner into three or four twigs (Fig. 5A). They are probably the cores of the incorporated mandibular barbels and they support the posterior part of the disc like umbrella ribs. Between the supporting structures the connective tissue of the disc is loose and includes wide spaces.

The sensory buds on the ventral surface have been mentioned. On the dorsal surface of head, trunk and fins, in the deeper epidermal layer, are large club cells staining pink with Masson's triple stain (like the huge cells of the pectoral gland); and in the external layer of the epidermis over the whole surface and inside the mouth are much smaller mucus cells, staining pale blue. I use the nomenclature of Bhatti (1938), who followed Rauther, 1937 and others.

## The Mungo specimens

The Mungo specimens of *Chiloglanis* belong to two species, one of which I identify with *C. micropogon* Poll, 1952; the other I describe as new, naming it after the collector *C. disneyi*.

Both species have the mandibular barbels almost entirely incorporated in the disc, a row of minute ciliiform teeth in the membrane behind the premaxillary symphysis and very small mandibular teeth in comparison with several other species.

They are distinguished from each other (see Table 10) by the size of the eyes in adults and their distance from the posterior nostril; by the interorbital width; by the position of the pelvics, more posterior in *C. disneyi*; the shape of the caudal fin, more deeply forked in *C. micropogon*; the number of soft dorsal rays, 6, rarely 5, in *C. micropogon*, 4 or 5 in *C. disneyi*; the number of mandibular teeth, 8–12 in *C. micropogon*, 15–20 in one row in adults in *C. disneyi*; and in adults by details of the premaxillary dentition. In addition our biggest specimens differ in the pattern of bosses on the ventral surface of the oral disc.

The proportions are difficult to measure consistently because of different positions in which the disc has been fixed, but those used for specific distinction are sufficiently contrasted in adults to be reliable.

## ***Chiloglanis micropogon*** Poll, 1952

Poll, 1952: 228 figs. 3, 4 (Eastern sources of the Congo, affluent streams of Rivers Ulindi (Kabare Territory) and Luhoho (West Kivu)); Daget, 1954: 307 fig. 116 (Rivers Tinkisso and Niandan, upper tributaries of R. Niger).

Several specimens of this species were caught from under stones by Dr Disney in the upper Mungo at Baduma, its tributaries Blackwater, Wowe and Dilolo and in R. Billé, Meme system. It has not previously been recorded from Cameroun and this locality is distant from both the type localities and the upper Niger system whence Daget recorded it. Some hitherto unnamed *Chiloglanis* in the BMNH, collected by Welman in 1934 in R. Kaduna, Nigeria, comprise ten of this species and two *C. niloticus waterloti* Daget; and a single specimen from R. Lobi, South Cameroun, included by Boulenger in *C. batesii*, also proves to be *C. micropogon*.

The description set out in Table 10 and the following paragraphs is based on 11 specimens from the Mungo system and R. Billé, 21·5–35·5 mm in SL.

Head tuberculate in adult. Maxillary barbel 0·6–1·45 times diameter of eye; outer mandibular barbel absent or scarcely longer than the other fringing scallops of the lower lip, inner no longer.

TABLE 10

Critical characters in specimens of *Chiloglanis* of the Mungo system and R. Bille assigned to *C. micropogon* and *C. disneyi*

| | *C. micropogon* | *C. disneyi* | | *C. disneyi* ? | |
|---|---|---|---|---|---|
| | (11 specimens) | Holotype | | | |
| | | Wowe | Blackwater | Dilolo | |
| SL (mm) | 21·5–35·5 | 35 | 25 | 24·5 | 24·5 |
| Length of head (% SL) | 36·0–42·8 | 34·0 | 36·0 | 38·0 | 36·0 |
| Distance P–V (% SL) | 19·5–22·5 | 27·0 | 28·0 | 26·0 | 26·0 |
| Base of adipose (% SL) | 11·6–16·9 | 13·7 | 10·0 | 18·4 | 16·0 |
| Distance adipose to rayed D/base adipose | 1·15–2·0 | 2·25 | 2·36 | 1·2 | 1·5 |
| Length of snout (% length of head) | 53–65 | 70 | 68 | 56 | 62 |
| Diameter of eye (% length of head) | 11·75–18·8 | 12·4 | 11·1 | 15·0 | 16·7 |
| (% post-cephalic length) | 7·7–11·3 | 6·5 | 6·25 | 9·6 | 9·4 |
| (times in distance from nostril) | 0·65–1·0 | 1·9 | 1·6 | 0·85 | 0·8 |
| (times in interorbital width) | 1·05–2·0 | 2·5 | 2·2 | 1·6 | 1·4 |
| D soft rays | 6 (or 5) | 4 | 5 | 4 | 5 |
| Anal branched rays | 5–7 | 5 | 6 | 5 | 5 |
| Teeth lower jaw (one row, the longer) | 8–11 | 20 | 15 | 11 | 12 |

Teeth of the ventral face of the premaxilla in four series at the widest part, with bluntly pointed or chisel-shaped tips. A pair of smaller groups of very small teeth on the posterior face of the premaxillae, nearly meeting at the symphysis and behind the symphysis minute, extremely slender teeth, the posterior of which are arranged in a transverse row, with their tips appearing as a row of ciliiform teeth on a short membranous curtain (in which their bases are embedded).* The mandibular teeth are S-shaped, smaller than in many species, forming one row of 8–11 teeth, sometimes with a second row of replacement teeth. If the earlier set of teeth persists behind the replacements the latter may be a little more numerous (nearer the definitive number). Among the specimens used for this description two rows (8+10 and 10+10) are present in two. The Lobi specimen has 11+11 and the holotype (Poll, 1952) 12+12. In smaller specimens two rows are naturally more frequent.

Pectoral spine short, 12·4–17·8% SL. Dorsal spine from a little shorter than the pectoral to a little longer. Usually 6 branched rays in the dorsal, but 5 in one specimen. Anal with 7–9 rays, 2 of which are simple. Caudal forked, the middle rays

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* Dr Poll has kindly re-examined the types at my request and finds a similar row of fine teeth in them.

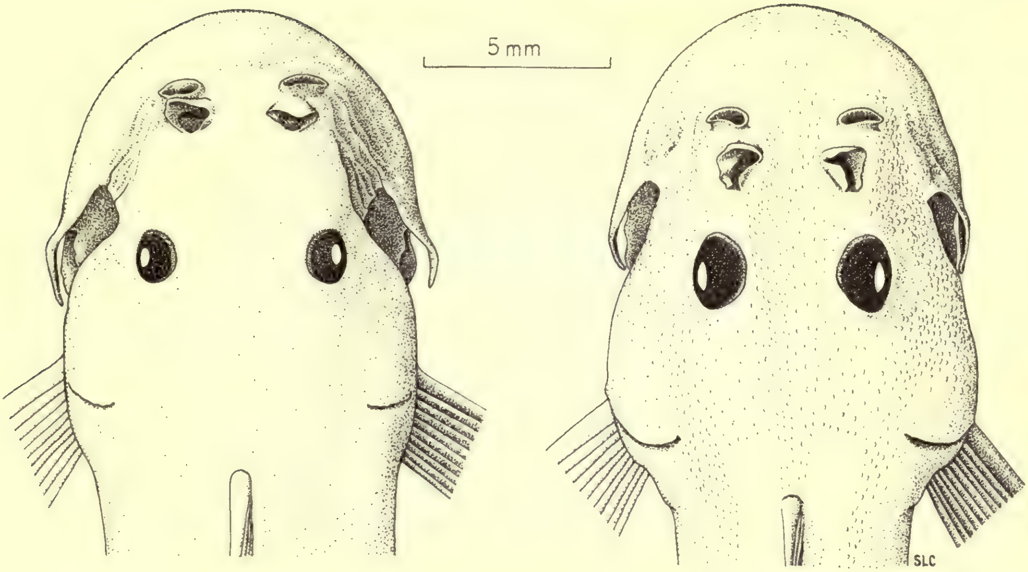

FIG. 6. Dorsal view of heads of, left, *Chiloglanis disneyi* and, right, *C. micropogon*.

being 10–17% SL, usually 10–15%, the longest rays 1·5–2·2 times as long, forming bluntly pointed or rounded lobes.

Ground colour yellow in life. Top of head irregularly clouded with dark grey. Behind this three black bands on the back which vary in width from narrow in some of the Dilolo fishes to continuous in the one from R. Billé; these extend on to the sides where they are usually less intense and spread, anastomosing irregularly. A dark vertical streak at base of caudal; a broad black band crossing each caudal lobe. Dorsal fin spine dark; a dark mark on leading pectoral edge and a streak from it crossing the fin, but only on the rays, absent in paler fishes. Pelvic and anal fins may be lightly marked. Ventral surface without melanin.

A female of 28 mm has ovarian eggs of 1·7 mm diameter, one of 35·5 mm of 1·9 mm. The genital opening is behind the anus between a pair of low ridges and behind it is a tapering urinary papilla. A similar papilla present in the male probably transmits the urinogenital duct.

The gut of one of the sectioned Mungo specimens contains filamentous blue-green algae and a few diatoms. Another contains a small arthropod, probably an ostracod, that had been feeding on the same algal mixture. The specimen stained with alizarin has a segmented invertebrate in its stomach. These observations point to a habit of feeding on the algal film of stones and its microfauna.

The small *C. micropogon* (up to 23 mm SL) from R. Kaduna resemble these in most respects, but the length of the adipose fin is variable and may even exceed its distance from the rayed dorsal, which has 6 soft rays in all. The dark colour is paler, much less contrasted with the ground colour than in most of the Mungo specimens or than in the *C. niloticus waterloti* found with them. A note from the collector (J. B. Welman) states that they were clinging to algae-covered stones.

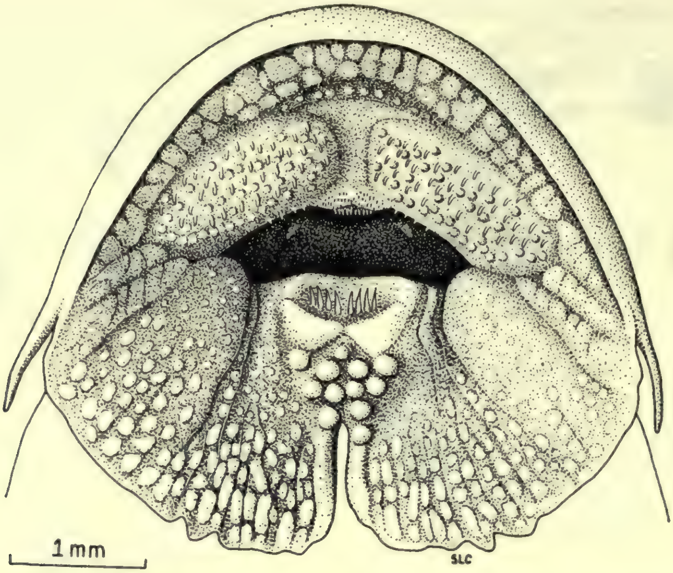

FIG. 7. *Chiloglanis micropogon.* Ventral view of disc showing sensory tubercles and teeth.

The syntypes of *C. batesii*, 27·5–33·5 mm in SL, have in common with *C. micropogon* the short barbels and the proportions of the head and eyes. They differ from it in lacking the differentiated ciliiform teeth, in the somewhat larger and fewer mandibular teeth (in the syntypes respectively 6 + 1, 6 + 4, 7, 7, 8), in the longer and stronger pectoral spine (17·7–24·8% SL) and in the produced caudal lobes with a dark band continuous around the fork (see Boulenger, 1911, fig. 363). I find 6 soft dorsal rays in all the syntypes, not 5 as reported by Boulenger; the last two are quite separate at the base.

*C. micropogon* appears to be related to *C. brevibarbis* Boulenger, a species of the upper reaches of the rivers of Kenya, both eastward flowing and those entering Lake Victoria from the North and East (Whitehead, 1958). In this species the barbels are less reduced, there are only 5 soft rays in the dorsal fin and there are usually no ciliiform teeth at the back of the posterior premaxillary group. Only in one specimen of several examined have I found such teeth, but they were of the same size as the other posterior premaxillary teeth. This species is represented in the BMNH by specimens mostly bigger than any taken in the Mungo.

MATERIAL EXAMINED

| BMNH register no. | Locality |
|---|---|
| 1909.4.29.97 | R. Lobi, S. Cameroun |
| 1935.5.29.25–34 | R. Kaduna, Nigeria |
| 1973.5.14.346 | R. Billé, Meme system |
| 1973.5.14.347–354 | R. Blackwater, Mungo system |

| BMNH register no. | Locality |
|---|---|
| 1973.5.14.355–359 | R. Dilolo, Mungo system |
| 1973.5.14.360–363, 371 | R. Mungo, nr Baduma |
| 1973.5.14.364–370 | R. Wowe, Mungo system |

### ***Chiloglanis disneyi*** n. sp.

HOLOTYPE. ♀ 35 mm in SL from R. Wowe, collected by Dr Disney in October, 1972, BMNH 1973.5.14.342.

The most important proportions and meristic characters of the holotype and three other specimens probably of this species are set out in Table 10. The following additional details are taken from the holotype.

Head smooth, without tubercles. Maxillary barbel 1·3 times diameter of eye; barbels of lower lip scarcely projecting beyond edge of disc. Pattern of bosses on ventral surface of rostral half of disc forming a series of frond-like units.

Teeth of ventral face of premaxillary with chisel-shaped tips, in 3–4 rows, the right and left groups well separated from each other. Between and behind them the minute teeth of the posterior face of the bone apparently on the 'stem of the claw' (see description on p. 358 above); the posterior of these forming a median transverse row of ciliiform teeth in the membrane, which is not raised as a 'curtain'. Mandibular teeth very small, close-set, in one row of 20.

Pectoral spine 18·5% SL; dorsal spinous ray 17% SL, as long as its soft rays, which number 4. Anal with 7 rays, of which the first two are simple. Caudal emarginate, with bluntly pointed lower lobe (the upper is incomplete), its middle rays 16% SL, rays of lower lobe less than 1·3 times as long.

Markings on body running together irregularly, giving a generally dark colour above the flanks; ventral surface white in preserved fish. A dark band at base of caudal fin and another crossing all the rays.

A second specimen, 25 mm in SL, from R. Blackwater (BMNH 1973.5.14.345), as can be seen from Table 10, agrees with this and contrasts with *C. micropogon* in the posteriorly placed pelvics and adipose, the longer snout, smaller eye and higher number of mandibular teeth. Its caudal fin is less deeply forked than in *C. micropogon*, but the premaxillary teeth and the pattern of bosses on the disc show no contrast with *C. micropogon*, perhaps because it is too young to have developed the specific pattern.

Two Dilolo specimens (BMNH 1973.5.14.343, 344) are placed tentatively with *C. disneyi* because of the posterior position of the pelvics, but their eyes are no smaller than in *C. micropogon* of the same size and the numbers of mandibular teeth are within the range for this species, although *C. disneyi* probably passes through a stage in which they are as few.

AFFINITIES. *C. disneyi* shows resemblances to four other species of *Chiloglanis*, each described and known only from a single specimen. These are: *C. congicus* Boulenger, 1920, from Stanley Falls (SL 75 mm), *C. marlieri* Poll, 1952, from a remote tributary of the Congo west of Lake Kivu (SL 45·6 mm), *C. polyodon* Norman, 1932, from the headwaters of R. Bagbwe, Sierra Leone (SL 44·6 mm) and *C. lamottei*

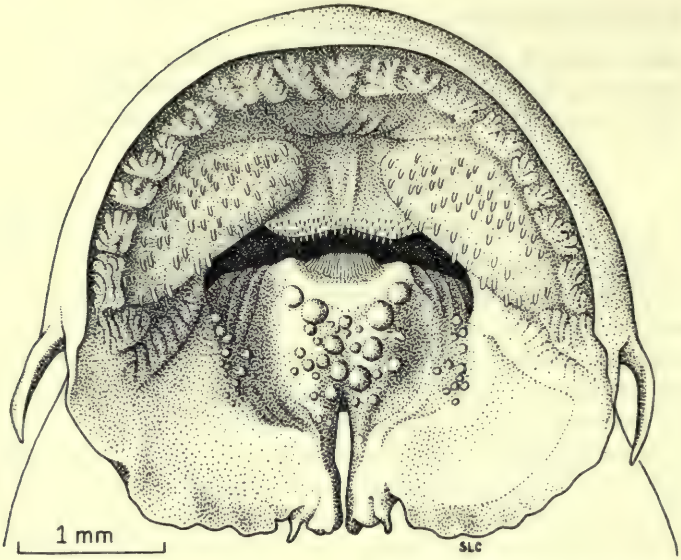

FIG. 8. *Chiloglanis disneyi.* Ventral view of head showing sensory tubercles and teeth.

Daget, 1948, from Mont Nimba (SL ca. 43 mm). These all have high numbers of mandibular teeth, posteriorly placed pelvics and small eyes well separated from each other and from the posterior nostril and all except *C. congicus* have fewer than six branched rays in the dorsal fin. At least in *C. polyodon* and *C. marlieri* there are no tubercles on the top of the head.

I have seen the types of *C. polyodon* and *C. marlieri* and rely on the descriptions of Boulenger and Poll (1952 : 231) for *C. congicus* and of Daget for *C. lamottei.* Comparison is not easy because of difference in size and preservation – the first three were fixed in alcohol and the edges of the disc are reflected over the ventral bosses, which are themselves flabby in contrast to our formalin-fixed specimens. In *C. polyodon* and *C. marlieri* the bosses have not the frond-like structure seen in the holotype of *C. disneyi,* but even in the Mungo we cannot be sure that this is specific. The 18 mandibular teeth of *C. congicus* are described as bunched together ('en bouquet', Poll) and this, together with the six branched dorsal rays, may be held to distinguish if from *C. disneyi.* The high number (44 Poll, 41 my count) of lower teeth in *C. marlieri* is made up of one row of 26, a widely interrupted inner row of 6 + 7 and 2 incompletely erupted outer teeth at the midline. Whether this should be interpreted as an inner, partly shed row, a functional row and two of a future replacement series, or whether it foreshadows the multiseriate dentition of *Atopochilus* I do not know. The line of teeth occupies a greater percentage of the width of the broad mouth-opening than that of *C. disneyi* does of the narrower mouth, and its unique appearance is against regarding it as conspecific with any of the other species under consideration, at least until more is known of the populations represented by the types. The posterior premaxillary teeth are of one size without an inner row of ciliiform teeth. In *C. polyodon* the 15 inner and 14 outer mandibular teeth are bunched together; the posterior teeth of the upper jaw are almost confined to the row of ciliiforms, with only 2 or 3 others, while the main premaxillary tooth-patches are large, on relatively massive bones (as in *C. marlieri*). The mandibular barbels are very short but the maxillary barbel is 1·6 times the diameter of the eye and the caudal fin is more deeply forked than in *C. disneyi*. *C. lamottei* has 14 mandibular teeth in one row, which according to the figure is more extended than in *C. disneyi*.

Although the distribution of *C. micropogon* accepted here suggests that species or species-groups of *Chiloglanis* may have a wide and discontinuous distribution in swift, clear waters, there does not at present seem to be enough evidence to justify uniting the Mungo form here named *C. disneyi* specifically with any other.

### Young *Chiloglanis*

Smaller specimens have not yet developed the features here relied on to distinguish the two Mungo species. The diameter of the eyes is more than their distance from the nostril, the teeth are not fully developed and the bosses on the disc are discrete. The caudal has a lunate posterior margin at SL about 12 mm and the adipose varies in extent, in some being longer than its distance from the rayed dorsal (cf. the small *C. micropogon* from Kaduna). The dorsal formula is I 5 in two, I 6 in the rest. They are all tentatively placed with *C. micropogon*.

## MALAPTERURIDAE

### *Malapterurus electricus*

*Silurus electricus* Gmelin, 1789, I : 1351 (Nile).

The electric catfish was abundant at both stations of R. Mungo and in the Wowe and is the classical species. Thys (1967 : 62) records it also from a rivulet near Barombi Kotto and discusses its occurrence in Fernando Poo. It is evidently one of the most successful of African freshwater fishes and is common throughout its wide distribution in west and central Africa excluding Lakes Victoria and Malawi and the upper Zambezi, although it is present in the middle and lower Zambezi and in R. Pungwe (Jubb, 1961).

Two specimens from R. Wowe were preserved (BMNH 1973.5.14.334, 335).

## CYPRINODONTIDAE

### *Epiplatys sexfasciatus* Gill, 1862

(Figs 9 and 10)

Gill, 1862 : 136 (Gaboon River ?) ; Trewavas, 1962 : 159 (Barombi Kotto and Barombi Mbo) ; Scheel, 1968a : 383, figs. ; Trewavas et al., 1972 : 47, 80.

*Haplochilus infrafasciatus* Günther, 1866 : 313 (Old Calabar) ; Lönnberg, 1903 : 39 (coastal river at Sanye, near Barombi Kotto).

*Epiplatys sexfasciatus rathkei* Radda, 1970b : 152 fig. 3 (R. Kake, nr Kumba).

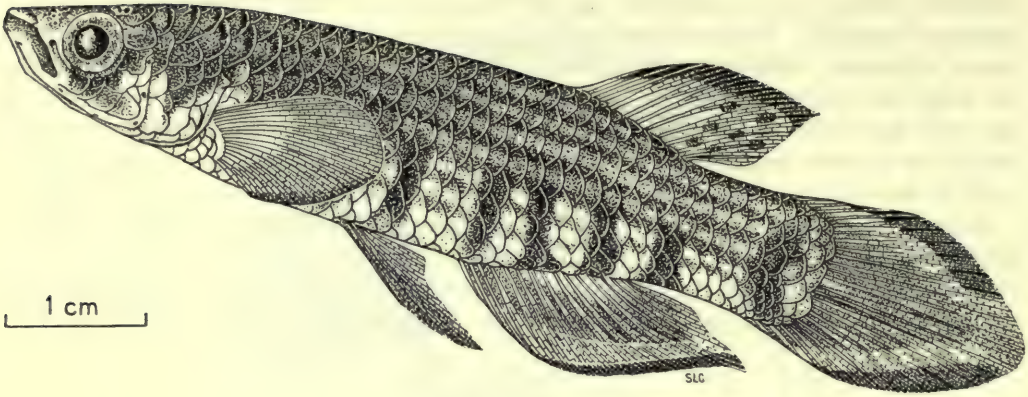

FIG. 9. *Epiplatys sexfasciatus* ♂ from Barombi Mbo, a six-barred specimen.

Barombi name at Barombi Mbo : longo katta.

This proved to be one of the most abundant species in the Kumba area and is one of the three non-endemic fishes in Barombi Mbo, where it is common around the edge of the lake and in both inflowing and outflowing streams. We did not catch it in Lake Kotto itself nor in Mboandong, our only specimens from this area being two females, one caught by hand-net in Tung Nsuria, a stream entering Kotto from within the crater, the other from R. Nyoke.

The male is richly coloured. The flanks are green, countershaded to dark green on the back and yellowish below. Each scale of the upper half of the body carries a red-purple spot. The dorsal fin has a black band within a narrow white margin and there is some black on the posterior rays ; the centre of the fin is yellow with red spots. The bluntly pointed or rounded caudal has a black marginal band above and below and within this a yellow band that reaches the edge on the middle rays and bears red spots and streaks in its upper section ; the middle and proximal part of the fin is greenish with darker rays. Both anal and pelvic have black marginal and yellow submarginal bands ; the proximal part of the anal is like the middle of the caudal. The head is dark with a gold spot on the occiput, the throat pale with a dark streak parallel to the lower jaw behind its edge. There are six to nine near-vertical dark stripes on the lower half of the body, the first behind the pectoral base, the last extending right across the base of the caudal. Stripes additional to the basic six are frequently shorter or narrower than the others.

The female is paler to watery buff ; dorsal and caudal fins are watery green with faint crimson spots, the other fins colourless. In some females observed the vertical bars were shorter than in males and might disappear altogether. In one in an aquarium they were seen to disappear on the side towards the light while they remained on the other. A vague horizontal band appeared when the fish was chased and disappeared when it was narcotized.

The fins of males are longer, the dorsal and anal in mature fishes extending beyond the base of the caudal, the pectoral beyond the origin of the pelvic and the latter beyond the origin of the anal. Males collected reached a length of 65 + 22 mm, females 55·5 + 16·5 mm.

One female contained transparent spherical eggs 1 mm in diameter with one or more transparent globules within them. According to Scheel, ripe eggs are bigger – 1·4–1·6 mm – and Loiselle (1971) gives 2·0 mm.

The type locality of *E. sexfasciatus* is a queried 'Gaboon River', and its distribution extends in coastal areas from the Congo to the Togo Hills. Scheel, who (1968a) compared samples from several populations morphologically, cytologically and by breeding experiments, found reduced fertility in hybrids between individuals from Barombi Mbo and western Nigeria, but concluded that the species comprises a chain of populations within which it is not profitable to name subspecies. But Radda (1970b) has named the population near Kumba *E. s. rathkei* and Loiselle (1971 : 37) describes the most western population as *E. s. togolensis*.

Radda distinguished *E. s. rathkei* by its rich colouring and by the higher number of vertical black bars (usually 8–10), but he did not compare with the population of Gabon, the presumed type locality. I have seen only two preserved specimens from Gabon and they have only six bars, but so have many specimens from Barombi Mbo and the Mungo. Scheel (1968 : 392) states that the pelvics in populations of South Cameroun and Gabon are 'short' in contrast to those of western Nigeria, without quantifying his statement. Loiselle's definition of 'short' is 'not reaching the anal fin', but this in inadequate. Western samples available to me do not contain enough mature males for a satisfactory comparison. Fig. 10 shows that the pelvic length in 28 males of 38–65 mm SL from Barombi Mbo and the Mungo system is 18·7–25·8% SL. In 5 males of 40·7–49·6 mm from near Lagos I find a ratio of 22·9–33·2%. Both samples include males of varying degrees of maturity and the figures show that Scheel's observation for the species in South Cameroun and Gabon can be extended to include the Mungo population in this character. I do not therefore consider that on present knowledge there is any justification for the use of a subspecific name to distinguish the Mungo members of *E. sexfasciatus* from those of the type locality. We found no difference between those from the lake and the streams.

*E. sexfasciatus* is reported from Fernando Poo by Boulenger (1915) and Thys (1967). Thys found it the most abundant freshwater fish on the island ; he discussed its distribution and synonymy. In Fernando Poo the vertical bars on each side number 6–9 and the pelvics in males up to about 70 mm SL are not greatly prolonged. Their length is given in terms of the length of head and so is not directly comparable with Fig. 10. In Thys's figured male the pelvic is about 20% SL and extends to about the 4th anal ray. The island populations evidently agree with those of the opposite mainland in essential features.

Recently (1971) Scheel has merged *Epiplatys* with *Aplocheilus* McClelland, but until the evidence is given I use the name under which this species is well known.

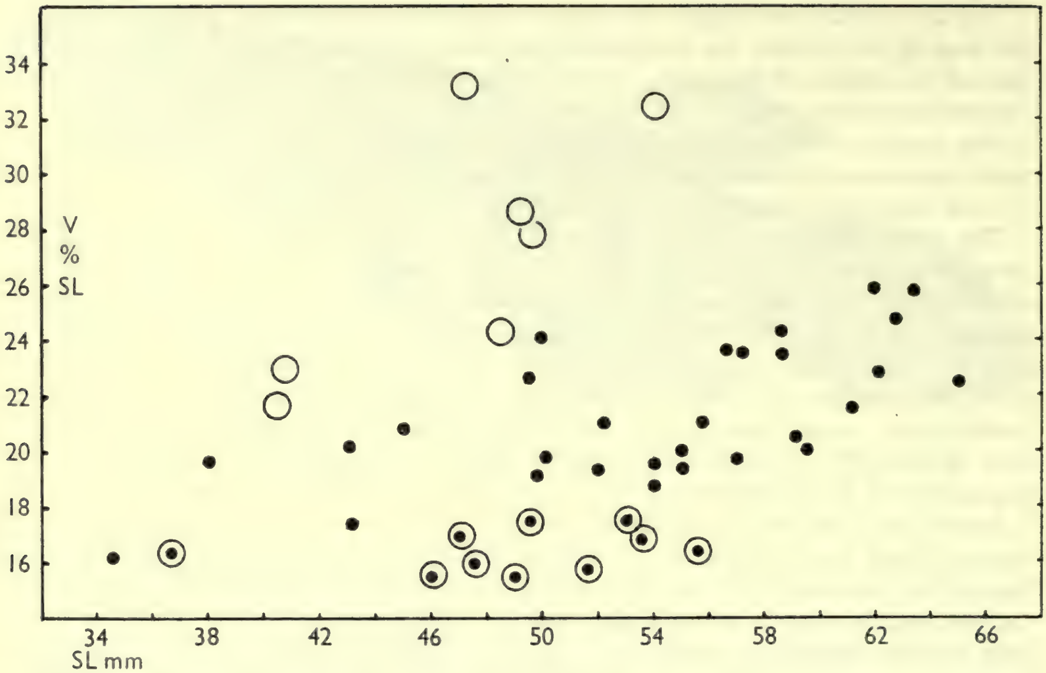

FIG. 10. *Epiplatys sexfasciatus.* Length of pelvic fins as % SL. ○ ♂♂ from southern Nigeria ; ● ♂♂ and ⊙ ♀♀ from Barombi Mbo and tributaries of R. Mungo.

## *Aphyosemion bivittatum* (Lönnberg, 1895)

*Fundulus bivittatus* Lönnberg, 1895 : 190 (a rivulet near the waterfall of R. Ndian, between Rivers Meme and Cross).

*Aphyosemion bivittatum* ; Scheel, 1966a (characteristics and interrelationships of populations) ; id. 1968a : 116–127, illustr. ; Thys van den Audenaerde, 1967 : 63 fig. 19 (Fernando Poo) ; Radda, 1971b : fig. 8 ; id. 1971c : 128.

*A. bivittatum* was caught in the following localities : R. Kake at Kake village (2 males), BMNH 1970.12.14.10–11 ; Tung Nsuia, flowing into Barombi Kotto (several), 1970.12.14.31–33 ; Edge of Mboandong (abundant, with *A. oeseri*) ; 1970.12.14.16–30 ; the stream Nyoke, south of Kotto, tributary of lower Mungo, 1970.12.14.12–15.

Males are easily distinguished from the other West Cameroonian species of *Aphyosemion* by the long streamers of the dorsal fin and upper and lower corners of the caudal. Both sexes and juveniles are further distinguished by the presence of two dark transverse stripes across the lower jaw ('chin-straps') separated by a white or yellow area.

The two longitudinal stripes that give the species its name were present in the living fish only in juveniles and some females. This is in agreement with the observation of Scheel (1966a) that the stripes appear only in females in fear or making submissive movements. In a male the two lead-grey stripes appeared on narcotization and on death.

This species also has fewer and larger scales than the other two – 25–26 in a longitudinal series, 12 around the caudal peduncle. Dorsal rays number 10–12, anal 12–15. These ranges are understandably narrower than those given by Scheel (1968a) in a much larger number of specimens from several populations.

Breeding colours were most marked in a male of 31 mm SL from R. Kake, from which the following notes were made.

Abdominal wall green, chest silvery ; scales of other parts of body each with a crimson spot, those of three upper rows continuous with three crimson streaks on the gill-cover ; a fourth crimson streak below eye ; two black chin-straps with yellow between them ; inter- and suboperculum yellow. Dorsal fin with crimson spots near its base and with yellow tip prolonged to extend well beyond base of caudal. Upper and lower tips of caudal also bright yellow and prolonged ; base of anal fin greenish with dark rays ; edge of fin black. Pectorals greenish yellow ; pelvics yellow.

In less mature males the anal has no black edge, but the edge may be pinkish. In another male soon after death the anal had crimson spots basally and a crimson margin ; the pelvics were yellow with a crimson edge, base and inner ray. Markings that appear black in life often become crimson immediately on death, presumably by contraction of the melanophores that are mixed with red pigment.

The biggest specimen in our collection is a ♀ of SL 41 mm, whose ovary contained clear, spherical eggs of 1·6 mm diameter, each with one or more minute clear globules inside it.

Scheel (1966a) has made a study, illustrated by fine colour-photographs, of different populations assigned to this species, which he regards as a superspecies. Some of the names in his tentative synonymy (1966a : 262), the types of which were from a wide area from R. Kribi to Lagos, may be open to doubt, but at least the distribution he gives, from Togo (?) and Dahomey to Rio Muni, is that of the group of populations to which our species belongs. Scheel has brought much evidence, including chromosome studies and crossing experiments, to establish the degree of relationship among them.

Thys (1967) recorded the species from Fernando Poo.

Among Scheel's colour-photographs of 1966a, his fig. 7 portrays a ♂ from R. Mboumboula and fig. 10 one from near Buea. Neither of them exactly corresponds to the description above, but I think the differences are no more than could be accounted for by modifications due to lighting and printing and by variation and phase of maturity (cf. Foersch's experience with aquarium-bred generations of *A. oeseri*, see p. 375, below).

### ***Aphyosemion celiae*** Scheel, 1971

Scheel, 1971 : 52, fig. on p. 55 (Mambanda, nr Kumba) ; id. 1972a : 193 (chromosomes) ; Radda, 1971 : 128 fig. 4, lower (Mayefe stream, nr Mambanda).

Our material consists of: 5 ♂♂, 25–29 mm in SL, 9 ♀♀ of 25–28 mm and 17 immature of 15–18·5 mm from Mangusu, most of them collected by Dr Disney a few days after the stream had been seen to be dry in that place; a ♂ of 25·5 mm from the neighbouring R. Moliba, also coll. Dr Disney; 2 ♂♂ and 9 ♀♀, 17·5–34 mm in SL from Lake Soden, coll. Dr J. Griffith. BMNH 1970.12.14.74–111.

Meristic characters, checked on 15 specimens from the Mungo tributaries and 11 from Lake Soden, are: D 10–12; A 14–15; scales in a longitudinal series 29–31, around caudal peduncle 13–16. Caudal rounded.

A colour sketch from one of our Mangusu specimens, a living, narcotized male, shows the characteristic dark arc, here violet, on the caudal as well as a band of the same colour on dorsal and anal, parallel to the margin but separated from it by a narrow white streak and a broader orange-yellow marginal band. The outer zone of the caudal was orange, but was interrupted on the middle rays by the dark blue-green ground colour of the fish as Scheel (1964 : 326) describes in one variant of *A. cinnamomeum*. The proximal part of the dorsal fin was streaked with red. The pelvics had a proximal blue-green zone streaked with red, followed by violet and red zones. The pectoral was yellow and no extension of this colour on to the body was noted. The body colour of this and other river males was green or blue-green with scattered purple spots. Red streaks were present on the head.

In females there are vague dark spots on the dorsal and upper parts of the caudal fins.

Notes on the Lake Soden population agree with this, although when they were observed (in aquarium) the body colour was pale light green to straw-coloured and the elements of the caudal pattern of males changed in intensity as the fishes swam about. They agreed with *A. celiae* in contrast to the related *A. cinnamomeum* in having the scales of the flank and caudal peduncle each with a carmine spot. In a well-coloured male dorsal, anal and caudal fins each had a broad orange marginal zone and a neutral proximal zone, between which a dark band appeared and disappeared, that of the caudal fin being looped as in *A. celiae* and *A. cinnamomeum* and in no other species known to me. The pectoral fin was yellow with a whitish lower edge.

Both the Mungo and Lake Soden specimens agree with *A. celiae* and differ from *A. cinnamomeum* in the presence of red or purple spots on the flanks, in the lower numbers of fin-rays and the small pores of the preopercular canal of the lateral line system. *A. cinnamomeum*, according to Clausen (1963) and Scheel (1968a), has D 13–14, A 16–17, and the preopercular pores are enlarged. Gyldenholm & Scheel (1971) and Scheel (1972a) also report a difference in karyotype between the two species, *A. celiae* in the type locality having 10 haploid chromosomes with 20 chromosome arms, *A. cinnamomeum* 20 chromosomes and 31 (Scheel, 1971) or 30 (1972a) arms.

The type locality of *A. cinnamomeum* is a stream about 70 km north of Kumba, but whether in the Mungo or the Cross system is not clear. In any case the localities where both species have been taken are in a relatively small area where affluent streams of Mungo, Cross and Meme rise. They share the peculiar caudal colour pattern and Scheel (1971 : 57) reports that both show signs of a short diapause before the egg begins to develop. In this connection it is interesting that this was the first species found when R. Mangusu flowed in its bed again, although of course the development of these specimens had already proceeded, probably in some upstream pool that had had at most a shorter period of desiccation than the river at the locality of our collection.

## ***Aphyosemion oeseri*** (Schmidt, 1928)

*Panchax oeseri* Schmidt, 1928 : 165 fig. on p. 166 (Fernando Poo).
? *Panchax vexillifer* Meinken, 1929 : 255 fig. ('Westküste Afrikas').
*Aphyosemion cameronensis* (nec Boulenger, 1904) ; Boulenger, 1915 : 48 (Fernando Poo specimens only) ; Thys van den Audenaerde, 1965 : 316 ; id. 1967 : 72, but not fig. 21 (Fernando Poo).
*Aphyosemion santa-isabellae* Scheel, 1968b : 332, fig. 1 (Fernando Poo).
? *Aphyosemion scheeli* Radda, 1970c : 178, figs 1 and 2.
*Aphyosemion santaisabellae* ; Foersch, 1971 : 20, 4 figs ; Berkenkamp, 1972 : 795, fig. on p. 796.
*Aphyosemion calliurum* s.l. ; Radda, 1971c : 128 fig. 4.
*Aphyosemion oeseri* ; Trewavas et al., 1972 : 47 (inflowing stream of Barombi Mbo) ; Roloff, 1972 : 381 (Fernando Poo).

Our preserved collections comprise :

| | Length (mm) | Locality | BMNH register no. |
|---|---|---|---|
| 1 | 33+9·7 | R. Moliba, upper Mungo | 1970.12.14.63 |
| 6 | 24·5+7 to 36·0+9 | Inlet stream of Barombi Mbo | 1970.12.14.64–69 |
| 1 | 28·1+8·6 | Barombi Kotto, near outlet | 1970.12.14.70 |
| 10 | 18·0+6·5 to 29·0+8·2 | Tung Nsuia in the Kotto basin | 1970.12.14.34–43 |
| 21 | 14·5+5 to 24·5+7 | Mboandong | 1970.12.14.44–62, 71–72 |

DESCRIPTION OF THESE SPECIMENS. Scales 29–31 in a longitudinal series (excluding one or two on the caudal fin), 14–16, usually 16 around the caudal peduncle. D 9–11 ; A (12 ?) 13–16 (mean 14·1). Tip of dorsal not extending to vertical of base of caudal fin ; origin of dorsal above 4th to 6th ray of anal. Caudal fin pointed in young, becoming rounded in female, cricket-bat shaped in male.

Often a grey or black spot on chin (no 'chin-straps').

Female watery green or brown, with a few red spots on flanks ; dull reddish spots on dorsal and upper part of caudal fins ; pelvics and anal greenish yellow with grey margins.

Male with bluish or greenish flanks with red spots on many of the scales, either irregularly scattered or partly confluent to form three main longitudinal lines from operculum to above anal fin ; no vertical markings on caudal peduncle ; two or three wavy red streaks on head below and behind eye. Dorsal fin greenish with dull red spots and sometimes a very narrow yellow edge ; similar spots on proximal part of caudal, which has a broad yellow band along its lower margin and a narrower one along the upper, both of them submargined with a dark grey or dark red band. Pelvics and anal yellow or salmon pink proximally, outside this a dark red band or row of contiguous spots that may be delimited with grey or light blue, and distally a broad bright orange band. Pectorals with a yellow to orange lower margin submargined with grey.

Many males lack the yellow on the tip of the dorsal and on the upper caudal margin, i.e. these probably develop later than the lower yellow marginal bands.

In the living fish the occiput has a metallic golden or silver spot.

Size : Our biggest and most colourful male had a total length of 45 mm (36 + 9) and the biggest female 42·7 mm (33 + 9·7).

ECOLOGY. See Green & Corbet in Trewavas et al. 1972, and Corbet et al. 1973.

DISCUSSION OF THE SYNONYMS. The fin-ray numbers given by Meinken for *A. vexillifer* are D 9, A 14. Scheel gives for *A. santaisabellae* D 10–12, A 14–16 (mean 14·6) ; his biggest specimen was 41 mm in SL.

The history of these names has been summarized by Scheel (1968a : 377 ; 1969 : 74), who dismissed *A. oeseri* as an invalid name. With this I cannot agree. The name was published by Schmidt (1928), attributed to Ahl and accompanied by a photograph and full colour description. In the same year Oeser (1928 : 374) had described his capture of cyprinodonts in the neighbourhood of Santa Isabel, Fernando Poo, and wrote that his collections, mainly herpetological, would be handled by Dr Ahl. Ahl never published on the cyprinodonts and although Schmidt no doubt relied on Ahl's authority for considering it new to science he satisfied the requirements of Art. 50 of the *International Code* as the author to whom the name should be attributed. The photograph in Schmidt's article very well matches that of Scheel's *A. santaisabellae*, and when to the one is added Schmidt's description and to the other Foersch's account of the aquarium offspring of specimens collected by Scheel as near as possible to Oeser's collecting ground there can be no doubt that they are the same species. Schmidt's article is the one piece of evidence (and the most important) that Scheel failed to see.*

Herr Roloff (1972) has also given reasons for adopting this name for the Fernando Poo population.

Meinken's *P. vexillifer* was based on specimens of a consignment of about a hundred of this species brought from 'Westküste Afrikas' by a friendly seaman to the 'Platy-Tischrund', Hamburg, where it was shown in October, 1928, the month of Schmidt's article on 'Neuimportierte Fische'. It does not seem far-fetched to suggest that this seaman was a member of the crew of the ship on which Dr Oeser travelled, though Dr Oeser (*in litt.*) does not think so. Oeser started his journey in a ship of a Hamburg line about the beginning of May, 1928, reaching Teneriffe on 5 May. The ship called at Liberia, Gold Coast, Fernando Poo and several other places (but not Nigeria or Cameroons) southwards to Walvis Bay, stopping a few days at each port, then turned homewards, a journey that might have occupied up to three months. Oeser collected very few fishes and none of the others mentioned by him could be confused with *A. oeseri* or *A. vexillifer*. Meinken himself realized (1929 : 257) the possible identity of *P. vexillifer* with *P. oeseri*, which he too considered not validly described. His drawing of *A. vexillifer* was reproduced by Arnold & Ahl (1936 : 303) and copied by Sterba (1959) and Scheel (1968a), becoming progressively less like the original. Scheel (1968a) considered it a synonym of *A. calliurum*, but the absence of lyre-like corners of the caudal in the original drawing does not favour that species, though no doubt it, with *A. oeseri*, belongs to the 'calliurum-group' of the genus.

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* I have the following statement from Dr Oeser: ". . . the fishes named after me, Panchax oeseri by Herbert Schmidt in 1928, were collected by me in Fernando Po as described in my article of 1928. Freiburg d. 20.10.1973 Dr. med. Richard Oeser."

Schmidt stated that Dr Oeser brought only two specimens, both males ; he does not say whether these types were preserved, but there is no record of them in the Berlin Museum (Dr Karrer, *in litt.*). The types of *P. vexillifer* were deposited in the Magdeburg Museum as no. 23/1929.

The next question concerns the specific identity of our mainland populations with that of Fernando Poo. Schmidt (1928) described the anal fin as having an outer orange band, then a row of red spots, then a yellow zone streaked with bluish. The margin of the dorsal fin was porcelain-white (cf. yellow in ours and Scheel's) and both upper and lower margins of the caudal were orange-yellow. In Scheel's types there were in the male no colour-zones in anal and pelvic fins, which were uniformly yellow. In Berkenkamp's figure the anal is yellow with a few red spots. But Dr Foersch (1971) got, in his first generation bred from Scheel's collections, a male with a dark red submarginal band in the anal fin, although this later disappeared. In the second generation a male developed the same colour-zones in pelvic and anal that we found ; they were permanent and appeared also in offspring sired by him (Foersch, loc. cit. fig. on p. 21). The difference, at least at first, was in the apparent timing, the upper yellow margins appearing before the lower in the Fernando Poo strain, the reverse in the mainland. Scheel also states that the Fernando Poo fishes had no grey or black spot on the chin, as the mainland ones often had. But in other species, e.g. *A. obscurum* (Ahl), this is said to appear in some individuals, so it is evidently facultative.

Arnold & Ahl (1936 : 293) described a species that Arnold received from near Douala and the lower Calabar River. They identified it as *A. cameronense*, but noted that it diverged somewhat from the types. Their description fits our specimens rather well. Their figure and description of '*A. oeseri*' were taken from a subsequent importation and do not seem to be this species.

The species at present known as *A. ahli* Myers 1933 (see Scheel, 1968a ; Foersch, 1968 : 367) differs from *A. oeseri* in having a lyre-shaped caudal fin in mature males. The aquarium strain described by Scheel and Foersch is from R. Mboumboula near Douala and is similar to ours except for the caudal and some vertical red markings on the caudal peduncle. The original description of *A. ahli* by Meinken (1932) under the name of '*Panchax* (*Aphyosemion*) *calliurus* Boul. var. *caeruleus*' is accompanied by a very pale colour-plate, but the description corresponds fairly well to the photographs of the Mboumboula strain by Scheel and Foersch, and to a transparency from the same strain kindly sent to me by Mr Roloff. This population seems to be related to *A. oeseri*, but at least subspecifically distinct. The specimens referred to '*P.* (*A.*) *cameronensis*' by Meinken in the same publication (1932) may well be *A. oeseri* itself.

The name *A. cameronense* (Boulenger, 1904) has been widely applied to cyprinodonts from Cameroun and eastern Nigeria, but Scheel (1968a) has rightly restricted it to the species whose males have two red longitudinal bands on the body, one of which runs close to the ventral outline. (He still (1972a : 193) mentions specimens from the Mungo system, but we did not find any.) Among the specimens listed in this species by Boulenger (1915) are two collected by Seimund in Fernando Poo and some from the lower Calabar River collected by Dr Leiper. These are now all faded, but none has any trace of two red bands, which have survived preservation in alcohol in the types of *A. cameronense*. The Seimund specimens, on meristic numbers and the shape of the caudal fin, are probably *A. oeseri*. Two males of Boulenger's Calabar sample have traces of the caudal and anal colour-zones, but their fin-ray numbers are rather low D 9 (f.5), 11 (f.1), A 11 (f.1), 12 (f.3), 13 (f.1), 14 (f.1). They are probably another species of the 'calliurum group'.

We have thus no firm evidence that the distribution of *A. oeseri* extends to the Calabar River, and it has not been reported south of Mount Cameroon.

Scheel and Radda have both collected recently in the Kumba area. The species that Radda (1971c) calls '*A. calliurum* s.l.' is probably our *A. oeseri*. One hesitates to suggest that Scheel, who knows *A. cameronense* from the type locality, would use that name for our species and fail to recognize its resemblance to the Fernando Poo population that he described as *A. santaisabellae*, but after hesitating I do suggest it. The chromosome number given in his Table 3 (1972a) for the Mungo samples is $n = 16$, chromosome arms 23, that of *A. 'santaisabellae'* $n = 20$ with 20 arms. The correspondence between various populations of a cyprinodont phenotype and their karyotypes is so irregular that Scheel has almost ceased to use the word 'species'. It would be interesting, however, to know the results of breeding experiments between the *A. oeseri* of Fernando Poo and the Mungo fish that we are calling by the same name.

The name *A. scheeli* was given by Radda to an established aquarium strain of unknown origin (illustrated also by Scheel, 1968a, p. 140, as the 'Burundi-Aphyosemion'). It is very much like our species and if the latter should prove to be different from the island form the name *scheeli* may be applicable, which would be unfortunate in view of the long aquarium pedigree of the types.

## ***Procatopus*** Boulenger, 1904

Boulenger, 1904 : 20. Type species *P. nototaenia* Boulenger.

The Aplocheilichthyinae are distinguished by having the pectoral fins attached at about the middle of the height of the body and the pelvics below or not far behind them. In the genus *Procatopus* the pelvics are in the most anterior position and the branchiostegal membrane is produced in adult males beyond the edge of the operculum as a bright yellow appendage.

Clausen (1959) divided *Procatopus* into two subgenera, the second, *Andreasenius* Clausen, differing from the nominate subgenus in the more posterior position of the pelvics, usually lower numbers of dorsal and anal fin-rays, a more slender body and in mature males by the elongation of upper and sometimes lower caudal rays.

Besides the type species, *P. aberrans* Ahl, Clausen named five other species of this subgenus in West Cameroon and Nigeria.

The nominal species of the subgenus *Procatopus* are :

*P. nototaenia* Boulenger, 1904 ; R. Lobi (Lobé), South Cameroun.

*P. similis* Ahl, 1927 ; Logobaba in the delta of R. Wouri.

*P. abbreviatus* Pellegrin, 1929b ; Yabassi, R. Wouri.

*P. glaucicaudis* Clausen, 1959 ; an upper tributary of the Cross system at the road from Kumba to Mamfe, 93 km north of Kumba.

After examining types of the named species, Clausen recognized *P. similis* and assigned specimens from R. Kumba to it (one presented to BMNH). He noted that numbers of scales and fin-rays are alike in all species and relied for specific distinctions on the position of the pelvics and details of coloration.

Scheel (1970) was inclined to consider each subgenus to represent one species and except in this way did not use the subgeneric concept. But in an appendix to the same article he modified this view, at least as regards the number of species, as a result of further collecting.

Populations sampled by us include two species of *P.* (*Procatopus*) and one agreeing better with *P.* (*Andreasenius*), but to some extent intermediate.

Our samples from R. Bille and the tributaries of the Mungo were collected by Dr Disney mainly in narrow-mesh basket traps, but from R. Blackwater by hand-net. Those from the inlet stream of Barombi Mbo were taken by Barombi women in closely woven baskets. The Lake Soden population was sampled by means of a butterfly net.

*Method of measurement.* Instead of the standard length Clausen used the 'post-premaxillary length'. I use instead a standard length including (but for this genus only) the projecting lower jaw.

In counting scales in a longitudinal series I begin with two above the pectoral fin-base. This gives two more than Boulenger's (and Pellegrin's ?) counts, but agrees with Clausen and Thys (1967).

## Evaluation of specific characters

*The position of the pelvics* may be expressed in three ways :

(a) Clausen's 'pelvics index', i.e. the horizontal distance between pectoral and pelvic bases as % distance from pelvic base to origin of anal fin. I have found these measurements to have a low repeatability. The distance P–V is about 0·5–2·0 mm measured as a projection and gives results that vary even with one operator on one fish. Moreover, my measurement on the paratype of *P. glaucicaudis* in the BMNH gives an index far outside the range recorded by Clausen for this species, and I am evidently not measuring in the same way.

(b) The distance from the tip of the lower jaw to the pelvic ('pre-pelvic distance') as % SL (Fig. 12). This was used by Poll & Lambert (1965) for *Hypsopanchax* and is more reliable in my hands than (a).

(c) The position of the pelvic origin relative to the lower ends of the ribs (Fig. 11 and Table 11). Because of the relative translucence of the tissues, even in alcohol,

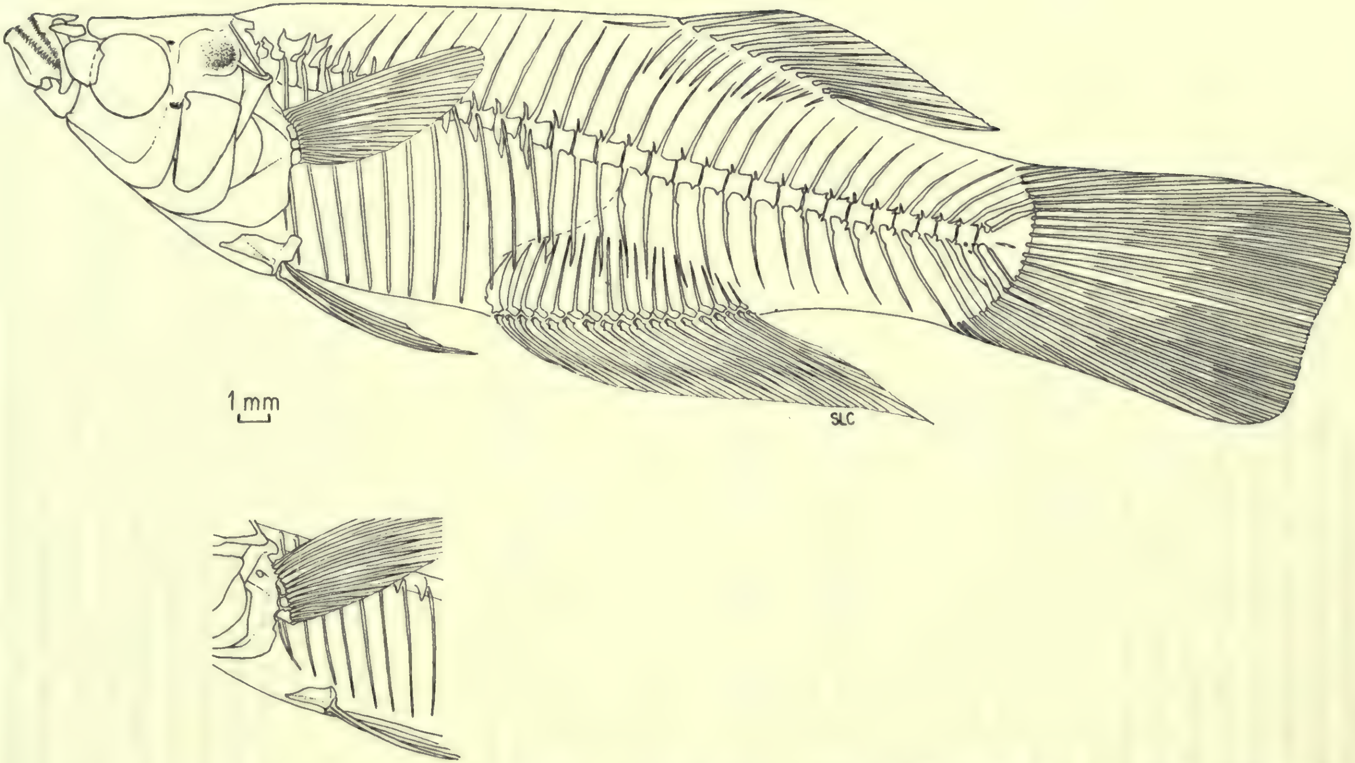

FIG. 11. *Procatopus similis*, skeleton of a specimen from the feeder stream of Barombi Mbo and, below, part of a similar preparation of a specimen of *P. lacustris* from Lake Soden, showing the position of the pelvic fin in relation to the pectoral fin and ribs. Alizarin preparations.

it is possible to see the ribs through the skin. The first rib is an exception, being usually hidden by muscles ; in an alizarin preparation it can be seen emerging from behind the cleithrum accompanied by the postcleithrum, a smaller bone. The second slopes downwards and backwards immediately behind the pectoral base and serves as a landmark when the first is obscure. It does not quite reach the ventral surface and I have described the attachment of the pelvic as 'at 2nd rib' when the anterior edge of the base of its anterior ray is at a point continuing the line of the rib.

TABLE II

Position of pelvics in populations of *Procatopus*

| | SL (mm) | Attachment of pelvics in relation to ribs |
|---|---|---|
| *P. similis* | | |
| R. Bille | 24·5–30·2 | Before 1st |
| Rivers Kumba, Mpanga and Kobe and inflowing stream of Barombi Mbo | 25·5–45·5 | At or before 1st |
| *P. nototaenia* (syntypes) | 25·5–36 | Between 1st and 2nd to just behind 2nd |
| *P. glaucicaudis* (paratype) | 25·5 | Just before 2nd |
| *P. glaucicaudis* ? | | |
| Kotto inlet stream | 23, 28·5 | Between 2nd and 3rd |
| R. Blackwater | 19–35·5 | 1st–2nd |
| R. Menge | 34–39·5 | At or just behind 2nd |
| R. Wowe | 29–34·5 | Between 1st and 2nd to between 2nd and 3rd |
| *P. lacustris* (Lake Soden) | 22–33·5 | 2nd to 4th, usually between 2nd and 3rd |

The anterior position of the pelvics is unique among African cyprinodonts and it is not surprising to find it farther back in the young. From R. Blackwater we have some very small fry in which, at 10·5–12 mm SL, it is at a point 33–43% of the distance from pectoral to anal, i.e. Clausen's index is 50–75. The definitive position is evidently reached quite early. In *P. similis* the pelvics are attached in front of the first rib already at 18·5 mm SL.

Scheel (1970) did not use the position of the pelvics except as a distinction between the two subgenera or, as he conceived it, between *P. nototaenia* and *P. aberrans*. Perhaps he too found Clausen's index impractical.

*Produced caudal rays* in mature males characterize the populations of subgenus *Andreasenius*, but this is a feature that may appear in only a few males of a collection even when they are intact (cf. Scheel, 1970) and the tips of the caudal rays often become damaged in preserved specimens (cf. Clausen on *P. plumosus*, 1959 : 278, our own collection from Lake Soden and the types of *P. nototaenia*).

Scheel (1970 : 13) found in a tributary of R. Lobé, very near the type locality of *P. nototaenia*, a population of *Procatopus* having the upper and sometimes lower caudal rays elongated as streamers. Since the number of dorsal fin-rays in the sample was also low he naturally expressed doubt as to whether *P. nototaenia*, or some of its syntypes, might be more closely related to *P. aberrans* than to the populations of

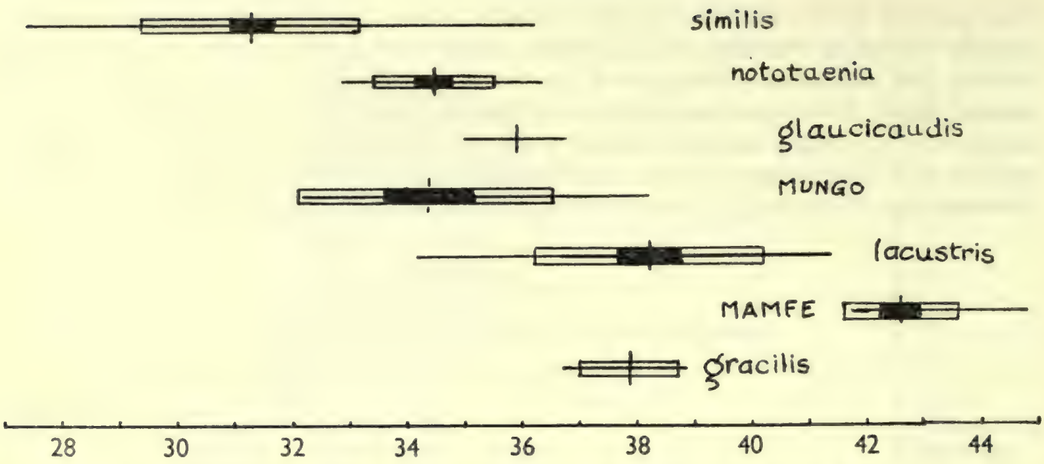

FIG. 12. *Procatopus.* Ranges, means, standard deviations and standard errors of means of prepelvic distance as % SL in *P. similis* (*n* = 26), *P. nototaenia* (11 syntypes), *P. glaucicaudis* (holotype and 2 paratypes), '*P. glaucicaudis* ?' of Mungo system (*n* = 10), *P. lacustris* (*n* = 14), 8 specimens from three populations in the neighbourhood of Mamfe (*P. nigromarginatus*, *P. roseipinnis*, *P. plumosus*) and *P. gracilis* of western Nigeria (*n* = 4).

Fernando Poo and southern Nigeria usually assigned to *P. nototaenia*. I have examined the caudal fins of the 16 syntypes of *P. nototaenia*. Of the 14 males only 6 have the upper caudal rays intact ; in 4 of these the fin is truncate, in the other 2 the third principal ray from the top is very slightly longer than the next, but there is nothing that could be called a 'streamer'. All these have the deep body and advanced pelvics characteristic of *P.* (*Procatopus*) as defined by Clausen (see Fig. 12) and melanophores are absent from the dorsal streaks described as yellow by Boulenger. Although the mean numbers of dorsal and anal rays are lower than in our populations of *P. similis* (Table 12) they are higher than those found by Scheel in his Lobé population (D 8–9, mean 8·3). Scheel does not mention the position of the pelvics, but it seems possible that both subgenera (or superspecies) are represented in the Lobé system.

*Coloration.* The general appearance of *Procatopus* is of a bluish translucence with the vertical fins variously tinted yellow or orange with a delicate edging of deeper orange (of which only the melanophore components remain in the preserved fish) ; the dorsum is grey with paired orange streaks or rows of spots variously mixed with or replaced by melanin ; sometimes also a median dorsal streak.

Clausen gave specific value to colour differences between populations of *P.* (*Andreasenius*), but Scheel, collecting later in the type localities, found that the colours no longer corresponded to Clausen's descriptions and concluded that they might change from generation to generation.

In contrast to Clausen's data notes on colour by ourselves and others are not sufficiently systematic to give a measure of the variation within populations, still less to give reliable contrasts between populations.

*Iris*. Types of *P. glaucicaudis* (from Clausen) – anterodorsally black, a gold spot behind this, else silver. '*P. glaucicaudis* ?' in R. Menge – red dorsally, else silver. *P. similis* in R. Kumba – yellow dorsally.

*Paired dorsal streaks or series of spots*. *P. nototaenia* types – paired yellow and median orange stripes (Boulenger). *P. glaucicaudis* types – brownish or yellowish grey streaks (Clausen). '*P. glaucicaudis* ?' in R. Menge – orange colour masked by melanin, seen only when looked for. '*P. glaucicaudis* ?' in Kotto basin – more dark pigment than in *P. similis*. *P. similis* in stream entering Barombi Mbo – conspicuous orange spots ; in R. Kumba – orange spots mixed with melanophores ; in R. Bille – orange spots present and between them a mid-dorsal orange streak. The population in Lake Soden – grey streaks, median streak black.

*Fins*. Dorsal and anal fins are generally described as pale yellow or flesh colour proximally, yellow or orange distally (our notes on R. Kumba and R. Menge specimens, Clausen's on R. Kumba and on types of *P. glaucicaudis*). Examined more closely, the pale proximal colour is produced by sparse melanophores and yellow pigment cells mixed, the distal by denser yellow cells. In a probably more intensely coloured *P. similis* from R. Kumba Clausen described these fins as bright yellow proximally, bright orange distally. At the other extreme we described the dorsal of a male from R. Menge ('*P. glaucicaudis* ?') as pale greenish with orange margin, its anal as greenish yellow with red spots. The anal and caudal often bear red or brownish spots. Scheel (1970) gave a wide range of fin colour in samples from tributaries of R. Wouri, from almost colourless through lemon, golden and orange to blood red. Scheel's journey extended from the type locality of *P. similis* in the delta to that of *P. abbreviatus* at Yabassi and evidently the *Procatopus* populations of that river system require further analysis.

These examples show that it is risky to use colour for diagnosis until more systematic studies have been made of it. No reliance can yet be placed on fin colour, but on the evidence *P. nototaenia* and *P. similis* (as identified here) have more yellow on the dorsum than *P. aberrans* and the species grouped with it as *Andreasenius* and in this feature *P. glaucicaudis* and the Lake Soden species are intermediate.

*Numbers of fin-rays*. The lowest ranges are those given by Ahl for *P. aberrans* – D 6–8, A 13–15 – but Ahl was apt to under-count (see Holly, 1930) and I consider here only Clausen's counts and my own. The main contrast is between the species of *P.* (*Andreasenius*) on the one hand, in which they are D 7–9, mode 8, and A 14–17, mode 15 (nearly approached by 16), and *P.* (*Procatopus*) on the other, with D 8–12, mode 10 or 11 in different species and A 15–20, mode 17 or 18 in different species. See Table 12. Between them the Lake Soden sample is intermediate with strong modes of 10 for the dorsal and 16 for the anal.

*Depth of body*. On the whole, species of *P.* (*Andreasenius*) are more slender than *P.* (*Procatopus*), but this is a character showing positive allometry with the standard length.

*Chromosomes*. Scheel (1970) states that in species from both sections of the genus the karyotype appears to be identical, with $n = 24$.

TABLE 12

Frequencies of dorsal and anal fin-ray numbers in samples of populations of *Procatopus*

| | Dorsal | | | | | | | Anal | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 8 | 9 | 10 | 11 | 12 | Mean | SD | 15 | 16 | 17 | 18 | 19 | 20 | Mean | SD |
| *P. similis* | | | | | | | | | | | | | | | |
| R. Bille | | | 2 | 1 | | 10·33 | 0·58 | | 2 | 1 | | | | 16·33 | 0·58 |
| Rivers Kumba, Mpanga and Kobe | | | 2 | 8 | 8 | 11·33 | 0·69 | | 3 | 7 | 6 | 2 | 1 | 17·53 | 1·07 |
| Barombi Mbo inlet stream | | | | 15 | 3 | 11·17 | 0·38 | | | 3 | 11 | 4 | | 18·05 | 0·64 |
| *P. nototaenia* syntypes | 1 | 3 | 10 | 2 | | 9·81 | 0·75 | 2 | 5 | 6 | 2 | | | 16·53 | 0·84 |
| *P. glaucicaudis* ? | | | | | | | | | | | | | | | |
| Fernando Poo (Thys) | | 1 | 14 | 7 | | 10·27 | 0·55 | | 8 | 18 | 5 | 1 | | 16·97 | 0·74 |
| Kotto inlet stream | | | 2 | | | | | | 2 | | | | | | |
| Rivers Menge, Wowe and Blackwater | | | 10 | 5 | 3 | 10·61 | 0·78 | | 5 | 8 | 4 | | | 16·94 | 0·75 |
| *P. glaucicaudis* types (from Clausen) | | | 6 | 5 | 1 | 10·58 | 0·67 | | 1 | 8 | 1 | 2 | | 17·33 | 0·89 |
| *P. lacustris* | | 4 | 23 | 1 | | 9·89 | 0·42 | 1 | 22 | 4 | | | | 16·11 | 0·42 |

## Sexual dimorphism

Our catches proved to contain very few females and the explanation is almost certainly selectivity of gear acting on a size difference between the sexes. In Lake Soden and the inlet stream of Barombi Mbo the mesh was finer and we got more females. Even in *P. similis*, where males reached 45·5 mm SL our biggest female was only 33 mm. This size difference was also noted by Clausen (1959).

I confirm the presence in mature males of the prolonged branchiostegal rays that form a bright yellow ornament at the lower edge of the gill-cover. In *P. similis* this was beginning to grow out at SL 25·5 mm. In our biggest male from Lake Soden (34 mm SL) the appendage is still not as long as in even smaller *P. glaucicaudis* and *P. similis*, and in smaller specimens the branchiostegal membrane projects only slightly and almost evenly beyond the opercular bones, with a crenulate edge.

In mature males the posterior rays of dorsal and anal fins may be elongated to form a short point, but the most striking sexual difference in these fins is the elongation of the base of the anal in males (Table 13). This brings the origin of the dorsal over the middle of the anal in males and over the posterior rays in females (although in none of ours is it over the last ray as in Thys's fig. 23 of 1967). The same dimorphism was described by Poll & Lambert (1965) in *Hypsopanchax jobaerti* and *Hylopanchax silvestris*, the latter having also a slight, but even prolongation of the branchiostegal membrane, but only to the degree manifested by immature males of *Procatopus*.

In mature males of all populations examined the pelvic fin is longer than in females and, as Clausen described for *P. glaucicaudis*, it is the third ray that is longest or the third with the outer fork of the fourth. In one of the females of the syntypes of *P. nototaenia* the first ray is produced a little beyond all the others, which are subequal. In females of *P. similis* this elongation of the first ray is exaggerated (Fig. 13).

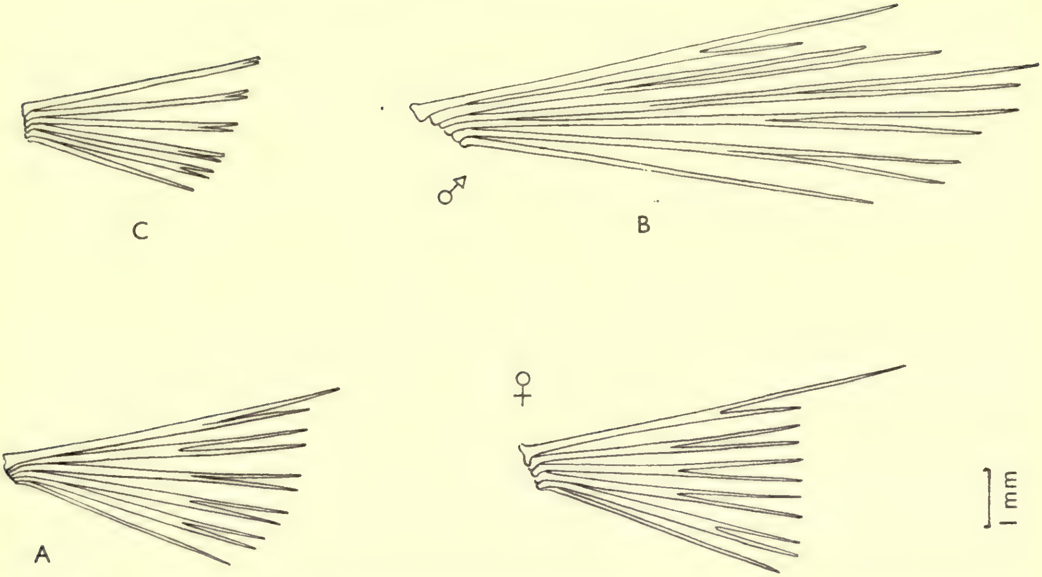

FIG. 13. *Procatopus.* Pelvic fins of, A, ♀ syntype of *P. nototaenia*, SL 26·5 mm; B, ♀ (30 mm) and ♂ (42 mm) of *P. similis*; C, ♀ (31 mm) of *P. lacustris.*

### TABLE 13

Sexual dimorphism in length of anal fin base in species of *Procatopus*

| Species and locality | No. of ♂♂ | SL (mm) | Anal base (% SL) | No. of ♀♀ | SL (mm) | Anal base (% SL) |
|---|---|---|---|---|---|---|
| *P. lacustris* | | | | | | |
| Lake Soden | 5 | 27–33·5 | 20·5–24·5 | 4 | 26·5–31 | 18–22 |
| *P. glaucicaudis* ? | | | | | | |
| R. Wowe | 3 | 29–34·5 | 25–27·5 | | | |
| R. Menge | 5 | 34–39·5 | 23·5–27 | 2 | 25·5, 32·5 | 23·5, 20 |
| R. Blackwater | 6 | 24–36 | 25·3–29 | | | |
| Kotto | 1 | 28·6 | 25·2 | 1 | 23 | 20 |
| *P. nototaenia* | | | | | | |
| R. Lobi (types) | 14 | 29·5–36 | 26·4–30·5 | 2 | 25·5, 32 | 19·6, 19·4 |
| *P. similis* | | | | | | |
| R. Kumba | 13 | 38·5–45·5 | 27·5–31·5 | 2 | 29–30·5 | 19–19·3 |
| R. Kobe | 2 | 29, 35·5 | 27·5–30·2 | 1 | 25·5 | 25·5 |
| Feeder stream of Barombi Mbo | 21 | 25·6–42 | (24·2)<br>25·3–29·7 | 6 | 22·5–33 | 19·3–24·9 |
| R. Bille | 2 | 24·5–30 | 27–30·4 | 1 | 26·5 | 22·6 |

Summary

| | | |
|---|---|---|
| *P. lacustris* | ♂ 20·5–24·5 | ♀ 18·0–22·0 |
| *P. glaucicaudis* | ♂ 23·5–29·0 | ♀ 20·0–23·5 |
| *P. nototaenia* | ♂ 26·4–30·5 | ♀ 19·4, 19·6 |
| *P. similis* | ♂ (24·2) 25·3–31·5 | ♀ 19·0–25·5 |

Contrast with this is probably what Clausen had in mind when he described the pelvic rays of *P. glaucicaudis* as decreasing in length gradually. In this the two females that we have from R. Menge and the Lake Soden females agree with *P. glaucicaudis*.

This suggests that the shape of the pelvics is not only sexually dimorphic but also characterizes females of *P. similis* and *P. nototaenia* vis-à-vis the other species, but its value needs confirmation from more females of *P. nototaenia* and the populations here included in *P. glaucicaudis*.

## Conclusions on *Procatopus* of Cameroons

The types of *P. similis*, two of which I have examined, have the pelvics in the extreme anterior position, before the first rib. The fins originate before or at the first rib also in our specimens from Rivers Kumba, Mpanga, Kobe, the inlet stream of Barombi Mbo and R. Billé, which are therefore identified as *P. similis*. They provide the further distinguishing characters of conspicuous yellow spots or streaks on the dorsum, high mean numbers of dorsal and anal fin-rays and an elongate first pelvic ray in females, all of which have yet to be checked in the type locality.

The population of Lake Soden has the pelvics significantly farther back (Table 11 and Fig. 12), no conspicuous yellow markings on the dorsum and lower numbers of dorsal and anal rays. It is very similar to *P. nigromarginatus* Clausen and the other populations of the Mamfe area, which Scheel suggests should be included in *P. aberrans*. In comparison with these, its higher mean numbers of rays and its peculiar ecology, together with its isolated position, justify a new name, although it may be only a subspecies of *P. aberrans*.

The types of *P. nototaenia* and specimens identified here as *P. glaucicaudis* from the upper Mungo tributaries are intermediate in the position of the pelvics and numbers of fin-rays. They seem to differ from each other in the amount of yellow on the dorsum and in the shape of the pelvics in females, but more data are required on these features.

The population of Fernando Poo according to Thys's description seems to agree with the Mungo *P. glaucicaudis* (position of pelvics, shape of pelvics in females, absence of yellow on dorsum) as do a few specimens taken in the Kotto area.

Queries still hang over the population of the Wouri system from which Pellegrin named *P. abbreviatus* and those of R. Lobé in which, as well as *P. nototaenia*, there is according to Scheel (1970) a species resembling *P. aberrans*.

## ***Procatopus similis*** Ahl, 1927

(Figs. 11–13, Tables 11–13)

Ahl, 1927 : 79 (Logobaba, eastern side of Wouri delta).

LECTOTYPE. SL 37 mm, Zool. Mus. Berlin 17772.

LECTOPARATYPE. SL 36 mm, Z.M.B. 22712. Both selected in 1965 by Clausen, but selection not published. Examined by me in 1972.

Our collections comprise 56 specimens, 18·5–45·5 mm in SL, from the inlet stream of Barombi Mbo, from R. Kumba and its tributary Mpanga Water, R. Kobe (all Mungo system) and R. Billé (Meme system). BMNH 1973.5.14.508–548.

The details of the following description are taken from a varying number of these as the variation seemed to demand. The types are included in the ranges but not in the means.

Pelvics attached below pectoral base, at or (usually) in front of first rib ; pre-pelvic distance 27·5–36% SL (Table 11, Figs. 11, 12). Depth of body 29–40% SL, of caudal peduncle 17–21. Dorsal fin-rays 10–12, mode 11, mean 11·15 or 11·3 in samples from different populations. Anal 16–19 (20), mode 18, mean 17·5 or 18·1. Scales 29 or 30 in a longitudinal series, 12 around caudal peduncle. Outer ray of pelvic in female produced to vent or origin of anal, other rays remaining short (Fig. 13).

Paired row of orange spots on the back conspicuous, in some a median orange streak between them.

The specimen with 20 anal rays has the 20th ray double, consisting of an anterior branch weakly forked and a posterior simple branch, the two fused or closely applied at the base. The well-defined modes in fin-ray numbers in the sample from the inlet stream of Barombi Mbo (Table 12) are the mark of a restricted and isolated population.

ECOLOGY. Inhabits running water and feeds on insects, taken mainly from the surface but also from the bottom (Green & Corbet in Trewavas et al., 1972).

There is no true contrast with *P. nototaenia* in Ahl's description, but the examined types have the pelvics originating in front of the first rib. The fin-ray numbers are equivocal (D 10, 11 ; A 17, 18).

### ***Procatopus nototaenia*** Boulenger, 1904

(Fig. 12, Tables 11–13)

Boulenger, 1904 : 20 (R. Lobi, South Cameroun) ; id. 1915 : 79, fig. 66 (Lobi, Kribi and Cross Rivers).

DESCRIPTION OF THE SYNTYPES. 14 ♂♂ and 2 ♀♀, 25·5–36·0 mm in SL.

Pelvics attached just behind pectoral base, from behind first rib to behind second ; prepelvic distance 32·0–37·5% SL (Table 11). Depth of body 31–34% SL, of caudal peduncle 18·4–20·8. Dorsal fin-rays 8–11, mode 10, mean 9·8 ; anal 15–18, mean 16·5. Scales 28 or 29 in a longitudinal series, 12 around caudal peduncle. Outer ray of pelvic in (one) female produced a little beyond the others (Fig. 13). Paired yellow and median orange stripes on the back conspicuous (Boulenger).

Boulenger does not state whether he relied on the collector's field notes for colour or on the condition of the preserved fishes. In the position corresponding to the orange spots of *P. similis* there is a pair of melanin-free strips. Of the two female syntypes only the smaller has undamaged pelvics.

The four Kribi specimens recorded by Boulenger are all males, 27–34 mm in SL. The pelvics are attached between the first and second ribs or just behind ; the prepelvic distance is 32·0–33·5% SL. The few specimens in the BMNH from the Cross

River system and lower Niger are also males, so that without information on colour or shape of female pelvics there is no reason to remove them from *P. nototaenia*. Clausen (1959) included Nigerian specimens in this species, and Scheel (1970) published a photograph of one under this name.

### *Procatopus glaucicaudis*

Stenholt-Clausen, 1959 : 268, figs. 1, 2 and Table 2 (stream of Cross River system, 93 km north of Kumba) ; Radda, 1970 : 239 (stream near Baduma, upper Mungo system).

DESCRIPTION OF 16 SPECIMENS (14 ♂♂, 2 ♀♀). 24·0–39·5 mm in SL from Rivers Menge, Wowe and Blackwater, tributaries of the Mungo. BMNH 1973.5.14.429–444.

Pelvics attached behind pectoral base, behind first rib to between second and third ; pre-pelvic distance 32–38% SL (Table 11). Depth of body 26·4–38·0% SL, of caudal peduncle 16·3–20·3. Dorsal fin-rays 10–12, mode 10, mean 10·6 ; anal 16–19, mode equally 16 or 17, mean 16·94. Scales in a longitudinal series 28–30, around caudal peduncle 12. Lower jaw with a slight mental process. Females with pelvic rays decreasing gradually in length from outer to inner.

Yellow tinge in the dorsal streaks inconspicuous, masked by melanin.

Males reaching 39·5 mm, females 32·6 mm in SL.

Eleven young of 7·2–19·0 mm were collected with the adults in R. Blackwater. At lengths up to 12 mm the pelvics are situated more posteriorly, but at 19 mm they are already below the second rib. Two of 16 and 19 mm have been included for fin-rays in Table 12.

Radda (1970) identified specimens from a stream near Baduma (probably from the Wowe or Moliba) as *P. glaucicaudis*. The type locality is about 48 km farther North over the watershed separating the Mungo from the Cross system.

The reasons for including our specimens in *P. glaucicaudis* and for suggesting that the two from the Kotto basin and those of Fernando Poo recorded tentatively by Thys (1967) as *P. nototaenia* may also belong to this species are given on p. 384. Conversion of Clausen's ratios to % SL as used by me give lower but overlapping ranges for depth of body and of caudal peduncle (respectively 24·0–32·5 and 13·7–16·8), but Poul Winther's illustrations (Clausen, figs. 1, 2) could serve also for our samples.

The assignment here of the various samples to *P. nototaenia* or *P. glaucicaudis* gives an impression of the interruption of the distribution of *P. nototaenia* and the singularity of the fauna of Fernando Poo–Mungo that is hardly justified in view of the uncertainty expressed above, but the specific identity of the Fernando Poo and Mungo populations (excluding *P. similis*) seems reasonably certain and is in line with decisions about other species.

### *Procatopus lacustris* n. sp.

(Figs. 11–13, Tables 11–13)

HOLOTYPE. ♂ of 33·5 mm SL ; allotype ♀ of 30 mm ; BMNH 1973.5.14.456–7, from Lake Soden.

PARATYPES. 16 ♀♀, 15 ♂♂ and 19 sex indet., 17·5–33·0 mm in SL, also from Lake Soden, 1973.5.14.458–507, collected by Drs Green, Corbet and Griffith in April, 1970.

Pelvics attached behind pectoral base, from second rib to behind third or even (in specimens of 17–21·5 mm SL) at the fourth; pre-pelvic distance 36·0–41·5% SL. Depth of body 26·2–29·0% SL, of caudal peduncle 15·9–18·8. Dorsal fin-rays 9–11, mode 10, mean 9·9; anal 15–17, mode 16, mean 16·1. Scales 29–31 in a longitudinal series, 12 around caudal peduncle. Pelvic rays in female gradually decreasing in length from outer to inner. Process of branchiostegal membrane of male not reaching full development below SL 34 mm, and then less prolonged than in other species.

No conspicuous orange or yellow spots in the dorsal streaks, the median of which is grey.

The mouth is set at a slightly steeper angle than in other species and there is a slight mental process.

Males reach 34 mm SL, females 31 mm.

The food consists of planktonic Crustacea (Green, 1972 : 298; Green & Corbet, in preparation).

Known only from Lake Soden.

As can be seen from Fig. 12, the position of the pelvics in this species is more like that in the subgenus *Andreasenius* than in other species of *P.* (*Procatopus*). Unfortunately the caudal fins of all our specimens except two were damaged. In the two it is truncate, but we cannot be sure that in mature males the corners may not grow out as streamers. If that were so it would conform to the definition of subgenus *Andreasenius*, although the number of dorsal fin-rays is higher than in other species.

The existence of a *Procatopus* in Lake Soden was already known to Dr Thys van den Audenaerde before our visit.

## CICHLIDAE

### ***Hemichromis elongatus*** (Guichenot, 1859)

*Chromichthys elongatus* Guichenot in Duméril, 1859 (Gabon).

*Hemichromis fasciatus* form B, Burchard & Wickler, 1965; Burchard, in Reed et al., 1967 : 131; Corbet et al., 1973 : 314.

This species was not caught by us in the upper Mungo or its tributaries, the only specimen recorded in the Kumba area being one from the Billé, an upper tributary of the Meme.

In Barombi Kotto and Mboandong it was one of the commonest species around the edges of the lakes and it was caught not only in Nganjoke, the outlet stream of Kotto (Meme system) but also in R. Nyoke, the stream near Kotto that is a tributary of the Mungo. It was included in Mr Deveson's collection from near Tiko, 1951–2.

The characteristic five black blotches along the flanks were faintly prolonged to the dorsum. An intense black opercular spot had an iridescent red mark above and below it. The lower parts of the head and belly were flushed red in most individuals and the scales of the flank each shone with a green iridescent spot. The dorsal lappets, upper edge of soft dorsal and posterodorsal corner of the caudal were pale with a red edge. The iris was black or grey, in some with a red circum-pupillar ring.

The metallic green spots on the scale rows are characteristic of the 'B form' of *H. fasciatus* (Burchard & Wickler, 1965). Mr Loiselle informs me (*in litt.*) that this is sufficiently evident in preserved specimens to allow him to use for it the name *elongatus*, until now included in the synonymy of *H. fasciatus* Peters, on the ground that known specimens from the broad type locality of *C. elongatus* ('Gabon') belong to the B form, although the type specimen, preserved for over a century, no longer shows anything of the diagnostic colour-features. Mr Loiselle, who has a paper in preparation detailing his evidence, also noted a second colour-pattern criterion, applicable only to specimens of 100 mm SL or more. I have applied these tests to numerous samples in the BMNH, including some known to belong to the 'B form', and I find considerable support for Loiselle's claim.

On the same evidence the Kotto population also appears to be *H. elongatus*, although the essential test of breeding coloration and behaviour has yet to be applied.

Both Dr P. H. Greenwood and I have spent considerable time trying to find structural differences between the two species, without success.

The smallest ripe female recorded from Kotto was 60 mm in SL, one from Mboandong 52 mm. The genital papilla of the male is surrounded by a small scalloped fringe.

Young of about 16 mm SL are distinguishable from young *Tilapia* and *Sarotherodon* by the bigger mouth, thicker lips, minute, sharply pointed unicuspid teeth, the presence of two series of vague melanophore concentrations on each side, one along the dorsum, the other along the middle of the flank (not continuous stripes like those figured by Gosse (1963) for *H. fasciatus* and also present in some young from Sierra Leone), and the absence of a tilapia-mark.

The ecology is described by Corbet et al. (1973).

MATERIAL PRESERVED

| BMNH register no. | SL (mm) | Locality |
|---|---|---|
| 1969.1.13.12–15 | 28–29·5 | Kotto, coll. C. A. Wright |
| 1973.7.18.106–109 | 52–79 | Mboandong, 1970 |
| 1973.7.18.110 | 105 | R. Billé, 1970 |
| 1973.7.18.111–113 | 76·5, 61, 15 | Kotto, 1972 |

## *CHROMIDOTILAPIA* Boulenger, 1898

Boulenger, 1898 : 151. Type species *C. kingsleyae* Boulenger.

This genus, formerly merged in *Pelmatochromis* Steindachner by Pellegrin (1904), Boulenger (1915) and Regan (1922), has been revalidated as a subgenus by Thys (1968a) for the species with a hanging pad in the pharynx and no microbranchiospines (but excluding some small species with a large ocellar spot on the caudal and a sexual differentiation in the length of the pelvic fins). It is in this sense, but with full generic rank as implied later by Thys (1968b), that I now use it for the species in the region under review.

### Feeding mechanism : contrast with *Tilapia*

The characteristic hanging (or boot-shaped) pad (Fig. 14) is a hyperdevelopment of the glandular and sensory pad present in most (all ?) cichlid fishes on the roof of the pharynx anterolaterally to the upper pharyngeal tooth-plates. The ankle of the boot on its anterolateral side is delimited by a groove with unspecialized epithelium, above and behind which lie the gill-rakers of the first epibranchial, which in their simple slender shape are sharply differentiated from the swollen and tuberculate ceratobranchial rakers (Fig. 16). The pad itself is filled with rather loose, fatty connective tissue, rich in nerves and capillaries, in the midst of which (as also in cichlids with a sessile pad) is a flange of bone and cartilage that is an extension of the second epibranchial (see Trewavas, 1973). Sections show (Pl. 3 Figs. a and b) that the hillocks of the pad are richly supplied with taste buds, while scattered at the surface of the stratified epithelium are small spherical mucus cells ('beaker cells', but they have no stalk) staining sky blue with Masson's trichrome. Sections of the ceratobranchial of the first gill-arch reveal that its rakers and tubercles are also thickly set with taste buds distally while the epithelium of their proximal parts includes some small mucus-cells. There are tubercles on the roof of the buccopharynx and the inner side of the suspensorium as well as on the rakers, probably also bearing taste buds.

The sessile pads of *Tilapia mariae* and *Sarotherodon melanotheron* (Pl. 3 Fig. c and d) contrast histologically with the hanging pad. In them there are far fewer taste buds, the small beaker cells are more plentiful, and the main constituents of the epithelium are tubular secretory cells that extend through the depth of the stratified epithelium (*T. mariae*) or nearly (*S. melanotheron*). Their secretion occupies nearly the whole cell and takes very little stain, appearing very pale blue with Masson ; their nuclei are basal.

Such cells are completely absent from the hanging pad of *C. guntheri*, but similar long and abundant gland cells were described by Imhof (1935) in blennies that graze on the algal film of underwater surfaces in contrast to carnivorous members of the same or related genera. Rauther (in Rauther & Leiner, 1937), who quoted Imhof, himself found the same correlation between the presence of such cells and a diet of unicellular or filamentous algae, instancing *Plecostomus* and *Garra* and the pharyngeal sac of *Curimatus*.

Fishelson (1966, figs 9–13) found both sensory and secretory cells in the mouth, pharynx and oesophagus of *Tilapia tholloni* and *T. macrocephala* (= *S. melanotheron*) at the larval stage ; at this stage the epithelium is not so many-layered, but the size and abundance of the gland cells show that they are the precursors of the deep cells of the adult.

Stolk (1957) described columnar secretory cells in the pharyngeal pads of *Pseudocrenilabrus multicolor* [= *Haplochromis multicolor* (Schoeller)]. In this case he was looking for evidence of a secretion relevant to the survival of the mouth-brooded young, but their similarity to the cells in species of *Tilapia* that do not practise oral

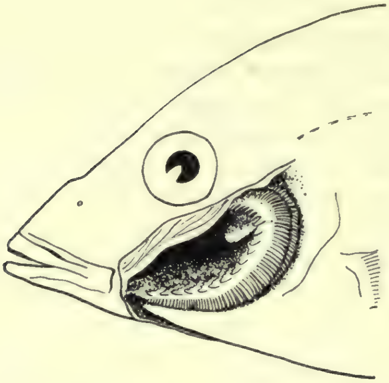

FIG. 14. *Chromidotilapia guntheri*, side view of head with gill-cover cut away to show the boot-shaped 'hanging pad' and the differently shaped gill-rakers on the epi- and ceratobranchial of the first arch. From Irvine & Trewavas, 1947.

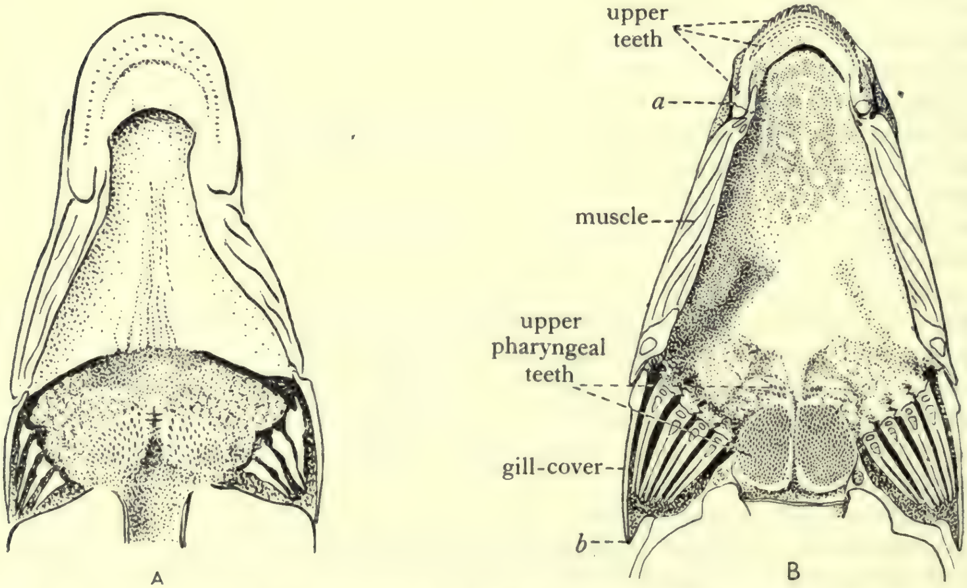
upper teeth
*a*
muscle
upper pharyngeal teeth
gill-cover
*b*
A
B

FIG. 15. Roof of mouth and pharynx in, A, *Chromidotilapia guntheri* and, B, *Sarotherodon melanotheron*, to show the upper pharyngeal teeth and different development of the pads and grooves on the roof of the pharynx.

incubation suggests that their function may be connected with feeding too. This species has the dental equipment of an omnivore. What substances are secreted is still unknown.

Similar secretory cells have been described in the pharynx of microphagous anuran tadpoles by Kenny (1969), who refers to concentrations of such cells as 'food-traps'. Greenwood (1953) recognized the same function for mucous secretions in the pharynx of *Sarotherodon esculentus* (*Tilapia esculenta*).

The series of epibranchial rakers in *Chromidotilapia* is long in comparison with that of most cichlids and in *C. guntheri* they may exceed in number those of the ceratobranchial. The frenum at the hinge between suspensorium and first gill-arch is at the upper end of the epibranchial, leaving a free passage between the groove and the upper part of the parabranchial chamber. The groove pinching off the hanging pad is continued around the front of the pad transversely to the midline and is sharply demarcated in front (Fig. 15A.

Elements of such an epibranchial arrangement are found in some species of *Pelmatochromis* in which the pad is sessile (see Trewavas, 1973), but in these the histology of the pad is unknown. The complete mechanism, including the hanging pad, is found in several cichlid genera not very closely related to *Chromidotilapia*. Examples are *Tylochromis* (West Africa, Congo basin and Lake Tanganyika), *Callochromis* (Lake Tanganyika) and *Geophagus* (South America). In *Geophagus jurupari* figured by Pellegrin (1904 : 104 fig. 27) the gill-rakers are on the edge of the pad instead of close to the epibranchial and are of a specialized structure,* but in *G. pellegrini* Regan they closely resemble those of *Chromidotilapia* both in structure and position and there are intermediate conditions in other species. The species in which this mechanism is developed are all bottom feeders and typically have the mouth set low at the end of a long snout with a deep preorbital bone. The feeding method of *Chromidotilapia guntheri* is described by Burchard (in Reed et al. 1967) as a vacuum-cleaner-like action and that of *Geophagus* by Sterba (1962 : 712) as a continual grubbing with its snout in the sand. The findings of Poll (1956 : 226ff.) on the food of *Callochromis* and those of Corbet et al. (1973) on *Chromidotilapia g. loennbergi* during our expedition confirm that the food is taken from the bottom.

It is plain that the arrangement of pad, grooves and epibranchial must affect the currents at the back of the pharynx, causing them to be different from those in fishes with a sessile pad, no transverse groove on the roof, a short series of blunt epibranchial rakers and the frenum near the epi-ceratobranchial joint.

Several species of the genus *Lethrinops* of Lake Malawi feed, as *C. g. loennbergi* does, on chironomid larvae. They too have a low-set mouth, long snout and deep preorbital, giving the same physiognomy as in *Chromidotilapia*, but their epibranchial arrangements are unmodified from the pattern usual in *Haplochromis*, to which they are related. A diagram of their feeding movements published by Fryer (1959) and Fryer & Iles (1972) shows the snout burrowing into the sand and finally the sand being shot out at the branchial opening.

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* Macroscopically they look like batteries of taste buds.

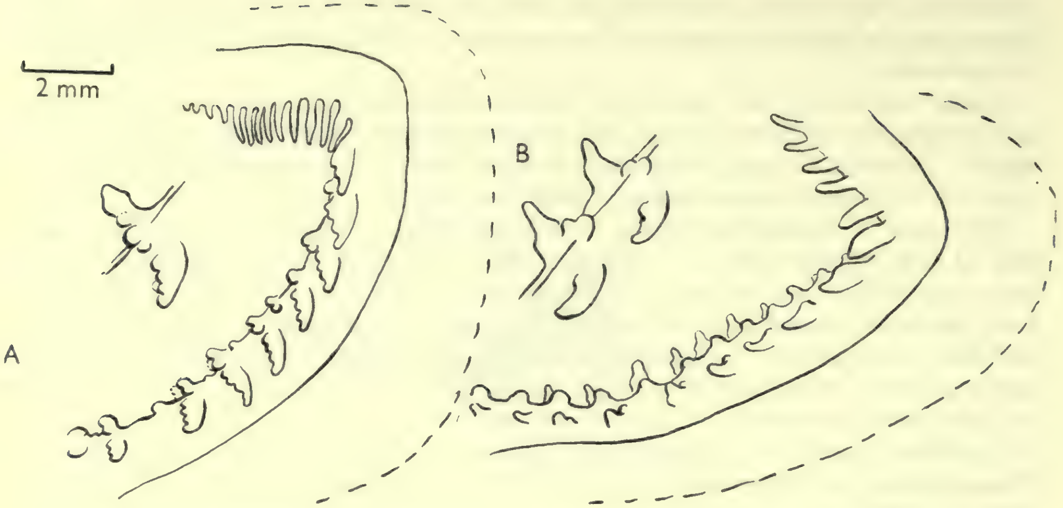

FIG. 16. *Chromidotilapia.* Gill-rakers of first arch in, A, *C. guntheri* of SL 69·5 mm from R. Menge and, B, *C. finleyi* of 76·5 mm from R. Blackwater. With each an oral view of part of the ceratobranchial. The broken line is the outline of the gill.

It may be that the hanging pad mechanism is a more efficient means of attaining this end, and the unusually plentiful supply of taste buds points to the selection at this place of items of food value from the general intake. The shape of the groove around the stem of the pad and the nature of the epibranchial gill-rakers (capable of a degree of filtering) suggest the possibility of re-entry of part of the respiratory and food-bearing current from the parabranchial chamber into the pharynx, but there are difficulties in reconciling this with the known bucco-pharyngeal movements in more normal perciform fishes (cf. Osse, 1969). Clarification must await investigation by experimental techniques.

The lips of *C. g. loennbergi* are thick and broad and the teeth are frequently embedded in the gums with the crowns worn off. Sectioned, the lower lip is found to have a stratified epithelium containing here and there a sensory bud, and with the cells of three outer layers flattened in a plane parallel to the surface. The dermis has a thick outer layer of collagen fibres and a tough fibrous connective tissue containing a bar of hyaline cartilage sheathed in fibrocartilage. Such thick lips occur in other populations of this species and must be an effective bull-dozing tool.

## Species in West Cameroon

In the Mungo tributaries and the outlet stream of Barombi Kotto two species of *Chromidotilapia* were found, *C. guntheri* (Sauvage) and a species related to *C. batesii* (Boulenger). I suggest that *C. loennbergi* (Trewavas) of Lake Kotto should be regarded as a subspecies of *C. guntheri* and I describe the other species as new.

*C. guntheri* shows the most advanced development of the feeding mechanism outlined above and the other species belongs to the least specialized part of the genus, having a shorter snout and preorbital, more teeth in the jaws, fewer epibranchial gill-rakers and fewer tubercles on the ceratobranchial rakers (Fig. 16). It also has a lower modal number of vertebrae (25 or 26, mode 26 ; cf. 26 or 27, mode 27, in *C. guntheri*) and some of the scales have a gothic arrangement of the circuli (roman in *C. guntheri*), both of which I interpret as relatively primitive characters.

### ***Chromidotilapia finleyi*** n. sp.

(Pl. 5 and Fig. 16)

? *Pelmatochromis nigrofasciatus* (nec Pellegrin, part) ; Boulenger, 1915 : 393, nos. 1–4, 8, 9, 17.
? *Pelmatochromis batesii* (nec Boulenger, 1901, part) ; Thys van den Audenaerde, 1967 : 91 fig. 28 (Fernando Poo) ; Roman, 1971 : 225 fig. 98 and pl. on p. 285.

HOLOTYPE. ♀ 73 mm SL, R. Nyoke, tributary of Mungo, SE of Lake Kotto. BMNH 1973.5.14.553.

PARATYPES. All collected during the expedition of 1970 or later in 1970 by Dr Disney.

| BMNH register no. | Sex | SL (mm) | Locality |
|---|---|---|---|
| 1973.5.14.554 | ♀ | 74 | R. Nganjoke, outlet of Kotto |
| 1973.5.14.568–71 | juv. | 29–44 | Stream W of Kotto |
| 1973.5.14.555 | ♀ | 63 | R. Mungo, between Baduma and Bolo |
| 1973.5.14.573–576 | indet. | 32·5–71 | R. Menge, tributary of Mungo |
| 1973.5.14.556–562 | 2 juv., 1 ♀, 4 ♂♂ | 50–75 | R. Blackwater, tributary of Mungo |
| 1973.5.14.563–567 | 1 ♂, 1 ♀, 3 indet. | 43·5–62·5 | R. Wowe, tributary of Mungo |
| 1973.5.14.572 | juv. | 31·5 | R. Kobe, tributary of Mungo at Ikiliwindi |

Named in honour of Mr Lee Finley, who generously provided the photograph of Pl. 5.

DESCRIPTION. Proportions as % SL (holotype in brackets). Depth of body 36–40 (40), length of head 35·6–39·8 (37·8), length of pectoral fin 24–28 (24), length of caudal peduncle 10·5–16·5 (12·0), 0·6–1·0 times its depth (0·75).

Proportions as % length of head. Length of snout 34·4–41·0 (37·5), diameter of eye 25·0–34·0 (25·8), depth of preorbital 18·1–21·8 (20·6), interorbital width 24·2–27·3 (26·6), length of lower jaw 36·6–39·0 (37·4), of upper jaw 31·4–34·6 (33·7).

Cleft of mouth at low angle with the horizontal, 10–20 degrees, exceptionally 30 degrees. Maxilla reaching vertical from front edge of eye. Gill-rakers on first arch (3–6)+(0–1)+(8–10), (5+1+10 in holotype). Lower pharyngeal bone arrowhead shaped, the blade about half as long as the median length of the toothed area, the teeth pointed, firm, not crowded.

Scales some with gothic arrangement of circuli, some roman ; 26–28 in the lateral line series, 3–3½ (3½) between origin of dorsal and lateral line, 16 around caudal peduncle ; 3 or 4 series on cheek.

Vertebrae 25 (f.2) or 26 (f.4).

Dorsal XV 9–10 or XVI 9, usually (including holotype) XV 10, total 24 in 3, 25 in 21.

Anal III 7–8, mode III 7.

Pelvic with first two (or 1½) soft rays produced as a filament or streamer, in adults of both sexes beyond origin of anal.

Caudal bluntly rounded or truncate with rounded corners.

*Colour* in life of holotype, a ♀ with ovarian eggs of 2·5 mm long diameter : lower flanks pink, lower parts of head with green and blue iridescence, lower lip white, opercular spot black ; spinous dorsal iridescent silver with yellow lappets and no black spots ; caudal without spots, its upper half yellow with some silver iridescence, lower half dusky ; pelvic with first 1½ soft rays grey and some blue iridescence on the inner rays.

Three immature from a stream near Kotto, 39–46 mm in SL, were dull green-grey in colour, with the dorsal lappets and upper edge of soft dorsal and caudal edged with red and with two or three series of green spots on the caudal. Preserved males from R. Wowe have no caudal spots, but those from R. Blackwater have them, dark grey as preserved.

Some, but not all, young of 31–39 mm SL have a dark round mark at the base of the anterior part of the soft dorsal, simulating a tilapia-mark.

Preserved specimens have nearly uniform countershaded ground colour, some with very faint and irregular indications of vertical bars below the dark back. Some that were pale straw-coloured when alive are uniformly whitish as preserved. In one or two there are a few oval clear spots on the soft dorsal and caudal.

The colours shown in Mr Finley's photographs (Pl. 5) agree very well with this description. Another photograph, not used here, illustrates a pale colour with two black horizontal bands said to be characteristic of a fish experiencing fear. Mr Finley, who succeeded in breeding the species in an aquarium, tells me (*in litt.*) that the tilapia-mark may be present in both sexes.

ECOLOGY. *C. finleyi* appears to be confined to clear running water ; we did not catch it in the lakes nor at the Mungo bridge where the water is brown, silt-laden and set with sandbanks. This is in contrast to *C. guntheri* which is found in both types of habitat.

AFFINITIES. Table 14 shows a comparison between *C. finleyi*, *C. batesii* as now restricted and certain samples from R. Kribi and Fernando Poo now considered to be nearer to *C. finleyi* than to *C. batesii*.

(i) Under *C. batesii* I consider only the three syntypes, another specimen from R. Benito and six of the Kribi specimens included by Boulenger in *P. nigrofasciatus* under the impression that *P. batesii* was its junior synonym. Two of the syntypes and two of the Kribi specimens are mature males and these have small dark spots on the caudal fin and on the posterior rays of the dorsal and anal (see Boulenger,

TABLE 14

*Chromidotilapia batesii*, *C. finleyi* and related populations

| | *C. batesii* | *C. batesii* ? | *C. finleyi* | *C. finleyi* ? | |
|---|---|---|---|---|---|
| | Benito | Kribi | Mungo and Meme | Fernando Poo | Kribi |
| *N* | 4 | 6 | 18 (+3) | 5 | 9 |
| SL (mm) | 56–93 | 61–98 | 43–74·5 | 42–86 | 68·5–90 |
| Depth (% SL) | 36–39 | 37–40 | 36–40 | 35·5–39 | 37·5–41·5 |
| Head (% SL) | 34·5–37 | 34·5–37·5 | 35·5–40 | 36–39 | 36·5–40 |
| Pectoral (% SL) | 23·5–26·5 | 25–26·5 | 24–26 (28) | 22–25 | 22·5–29 |
| Caudal (% SL) | 30–31·5 | 32·5–35 (♂)<br>31–31·5 (♀ ?) | 28·5–31·5 | 28–32 | (27·5) 30–33 |
| Preorbital (% head) | 21·5–22·5 | 20·5–25 | 18–23 | 20–22 | 19–21·5 |
| Interorbital (% head) | 26–28 | 27·5–31·5 | 24–27·5 | 22–24·5 | 24–27 |
| l.j. (% head) | 38–39·5 | 37–40 (43) | 36·5–42·0 | 38–39 | 38·5–43·5 |
| u.j. (% head) | 32·5–35·5 | 31·5–36·5 | 31·5–36·0 | 33–34·5 | 35·5–40 |
| Vertebrae 25 | – | 1 | 2 | – | 1 |
| 26 | 3 | 2 | 4 | 2 | 6 |
| 27 | 1 | 2 | – | 3 | – |
| Fin-rays | | | | | |
| D modal formula : | XV 10 | XV 10 | XV 10 | XV 10 | XV 9 |
| Totals 24 | – | – | 3 | – | 6 |
| 25 | 3 | 3 | 21 | 5 | 3 |
| 26 | 1 | 3 | – | – | – |
| Anal (soft) | | | | | |
| 7 | – | 3 | 14 | 5 | 8 |
| 8 | 4 | 3 | 5 | – | 1 |
| Scales l.l. | 26–28 | 26–28 | 26–28 | 27, 28 | 26 or 27 |
| Gill-rakers | | | | | |
| Upper | 3–5 | 4–5 | 3–6 | 3–5 | 5–7 |
| Lower | 10 | 9–11 | 8–10 | 9–11 | 8–11 |

For each sample are given the Standard Length (SL); number of specimens used (*N*) (for *C. finleyi* three small specimens are used for meristic characters only); proportions as % SL; depth of preorbital, interorbital width and lengths of lower (l.j.) and upper (u.j.) jaws as % length of head; and certain meristic characters counted in the usual way. For the gill-rakers of the first arch one at the epi-ceratobranchial joint is omitted.

1915 fig. 265). The preserved marking of the females, all considerably bleached, consists of a vague dark blotch at the base of the anterior part of the soft dorsal. The characteristic grouping of the spots in males is not found in *C. finleyi* (nor in the Kribi specimens now omitted from *C. batesii*) and resembles the pattern in *C. kingsleyae* and *C. caudifasciatus*. *C. batesii* is close to the latter, which differs from it mainly in the more elongate body (depth of body = length of head = 33·3% SL ; cf. in *C. batesii* depth 36–40, head 34·5–37·5% SL) and lower number of gill-rakers (7–8 on lower part of anterior arch).

In addition to the difference in colour-pattern, the numbers of vertebrae and dorsal and anal fin-rays have lower means in *C. finleyi* than in *C. batesii* (Table 15), although samples are too small for confidence in the significance of the differences. Likewise a different but overlapping range of relative length of head must be considered in

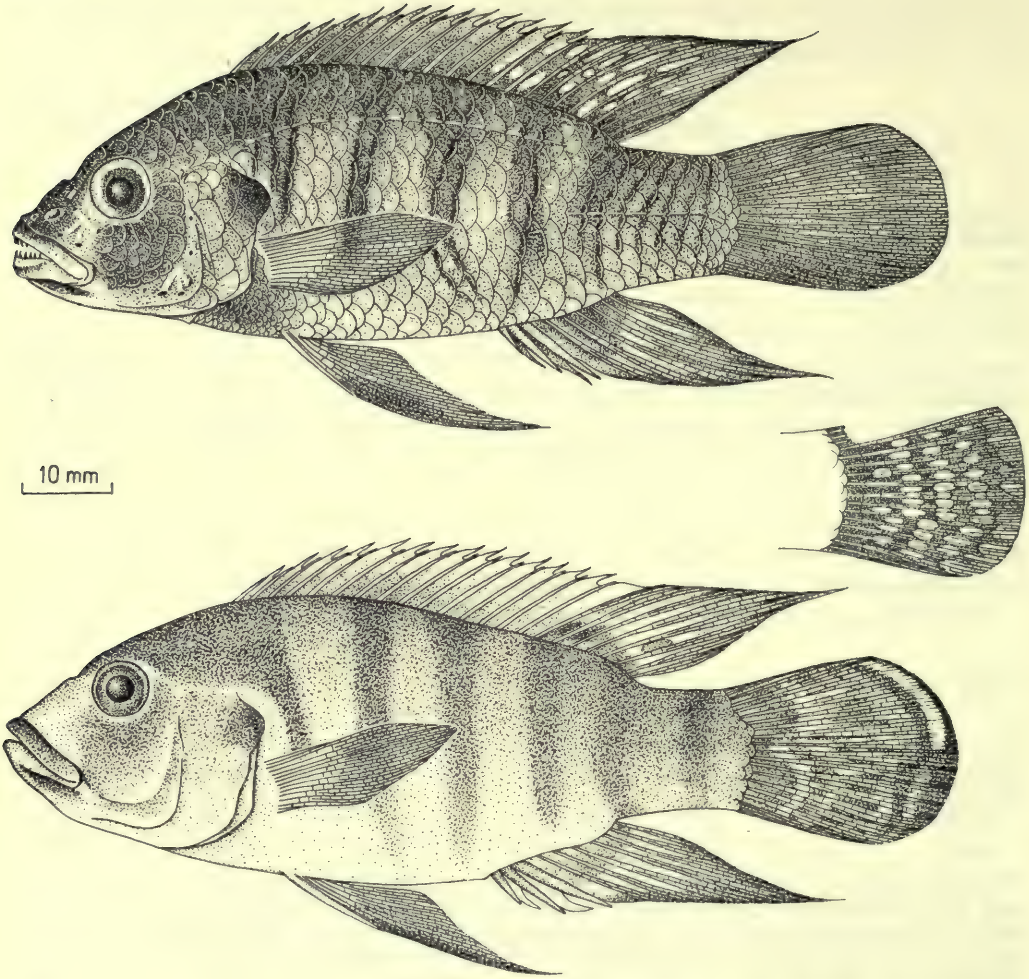

FIG. 17. *Chromidotilapia* sp. from R. Kribi, BMNH 1908.5.30.182 and 187. Above ♂, below ♀ to show contrast in preserved colour pattern. A damaged caudal fin of another ♂ is shown for variation in pattern.

relation to the fact that most of our specimens of *C. finleyi* are smaller than most of those available of *C. batesii*.

(ii) Other Kribi and Efulen specimens include mature males with a colour-pattern different from both *C. batesii* and the Mungo–Meme *C. finleyi*, characterized by the presence as preserved of white oval spots narrowly outlined in black on dorsal and caudal fins (Fig. 17). Vertical dark bars on the body are conspicuous in both sexes. Whether this pattern and the life colours can be included in the variation of *C. finleyi* must await further study of both populations. Meristic characters are nearer to those of *C. finleyi* than *C. batesii*, but among the proportions the size of the mouth, as expressed in the length of both jaws, is greater than in either and the cleft is usually at a higher angle with the horizontal (20–40 degrees, cf. 10–30 degrees in *C. finleyi*, 20–25 degrees in *C. batesii*).

(iii) The Fernando Poo specimens listed by Boulenger (1915) are not well enough preserved to determine the sex either from viscera or papilla. They have irregular black markings on the posterior part of the spinous dorsal fin and on the soft dorsal. Those on the male figured by Thys (1967) are a more regular variant of this pattern. In proportions they are similar to *C. finleyi* and have not the large jaws of mature Kribi specimens. Unlike these or the Mungo fishes sampled they include some with 27 vertebrae. I assign them provisionally to *C. finleyi*.

(iv) *C. schoutedeni* (Poll & Thys, 1967), from clear running water in the tributaries of the Congo at Yangambi and of the Lualaba, seems to belong to this group within the genus, and elements of the colour-pattern are reminiscent of the Fernando Poo samples. It differs from the other populations considered in having 29 scales in the lateral line series and the lower part of the cheek naked below 3 series of small scales.

Finally, I conclude that there are populations in the Mungo and Meme, in Fernando Poo and R. Kribi related to but specifically distinct from *C. batesii*. Whether they are conspecific with each other or must be subdivided can only be decided after further work on living specimens.

If they are conspecific it is evident that in the Kribi system the areas of *C. finleyi* and *C. batesii* overlap and this may be true also of R. Ntem. The photograph of '*C. batesii*' reproduced by Roman (1971) in colour (p. 285) and monochrome (fig. 98, p. 225) does not show the spot pattern characteristic of the vertical fins of male *C. batesii* (see Boulenger, 1915, fig. 265). The sex is not given ; it may be ♀ although the silver band on the spinous dorsal is less striking than is typical in *Chromidotilapia*. As in the holotype of *C. finleyi* the upper half of the caudal fin is yellow. Vertical bands on the body are as well marked as in the Kribi *C. finleyi* (Fig. 17). I suggest, therefore, that Roman's figure represents *C. finleyi* and not *C. batesii*. Alternatively, if it is *C. batesii* then the females of these two species are more alike than the males. Males with spotted vertical fins like those of the types of *C. batesii* were not encountered in the Mungo.

### Evidence from Scheel's chromosome studies

After most of the above was written I read Scheel's (1972b) report that he found two species in the neighbourhood of Kribi corresponding to the definition of *C. batesii* and very difficult to distinguish on preserved material. One of them, the 'northern form', has a chromosome number ($2n$) of 42, the other 44, although there are 80 chromosome arms in both. He states that they are different in reproductive behaviour and colour in life but gives no details. The photograph of '*C. batesii*' that he reproduces is the black-and-white one of Roman (1971).

Scheel's observation confirms my distinction of two Kribi forms, but leaves unresolved the questions of the identity of one of them with the Mungo species and of the full nature of the distinction from *C. batesii*.

## *Chromidotilapia guntheri*

*Hemichromis guntheri* Sauvage, 1882 : 317 pl. v fig. 1 (Assini, Ivory Coast).

For synonyms and comments on the synonymy see Trewavas, 1962 : 162.

DISTINGUISHING CHARACTERS. Snout long, 36·7–46·0% length of head (in specimens of SL 42·5–91·5 mm), depth of preorbital 21·8–27·7%. Teeth in adult in 2 series, occasionally a third, the 6–8 anterior of lower jaw stronger than those of the rest of the outer series and usually set forwards at a greater distance from the inner row. Gill-rakers on the ceratobranchial tuberculate, those of outer series of first arch with 3–6 tubercles. Vertebrae 26–27, mode 27. Scales 28, rarely 29 in lateral line series, 3½–4 from origin of dorsal to lateral line. Female with a broad silver-bronze band on the spinous dorsal fin, extending on to anterior soft rays and bearing small dark shapeless spots in 1–3 irregular rows or irregularly arranged ; and with a few very faint spots or none on the caudal. Leading edge of pelvic light iridescent blue in ♀, white in ♂.

The snout and preorbital measurements are still higher in bigger specimens.

### Comparison of populations (Tables 15 and 16)

Both the Mungo population and *C. g. loennbergi* agree with this diagnosis, but they differ from each other and from samples from Ghana and Nigeria as follows.

*Ghana and Nigeria*

Interorbital width (at SL 68–93 mm) 25–28% length of head. Gill-rakers on first epibranchial 7–10 (8–13 according to Loiselle, in the press). Total rays in dorsal fin 25–28, mode 27, modal formula XVI 11.

*Upper Mungo and tributaries*

Interorbital width (at SL 64·5–91·5 mm) 24·5–28% length of head. Gill-rakers on first epibranchial 7–11, usually 9–10. Total rays in dorsal fin 24–27, mode 25, modal formula XV 10.

*L. Kotto and its outlet R. Nganjoke* (*C. g. loennbergi*)

Interorbital width (at SL 73–90 mm) 21·2–26·0% length of head. Gill-rakers on first epibranchial 5–8. Total dorsal rays 25–27, mode 26, modal formula XVI 10.

The numbers of specimens on which the meristic comparisons are based can be seen in Tables 15 and 16.

This comparison shows that the Mungo samples differ from those from western localities in having fewer dorsal rays and that *C. g. loennbergi* differs from both in the lower number of epibranchial gill-rakers as well as a lower but overlapping range for the interorbital width.

### *C. g. guntheri* in the Mungo system

Our collection comprises 44 specimens caught in traps at five localities in the upper Mungo system, but 20 of these were taken at one time in R. Menge and 5 others came from the same locality at a later date ; 18 of the 23 specimens giving the modal formula of XV 10 were from these samples. This may therefore give a local and

TABLE 15

Upper (epibranchial) gill-rakers in samples of *Chromidotilapia guntheri**

| | *C.g. loennbergi* | | *C.g. guntheri* | |
|---|---|---|---|---|
| Upper rakers | Kotto | Nganjoke | Mungo | Ghana |
| 5 | 1 | | | |
| 6 | 3 | 2 | (2) | |
| 7 | 5 | 1½ | 3 | 2 |
| 8 | 2 | 1½ | 6 | 9 |
| 9 | | | 11 | 6 |
| 10 | | | 9 | 2 |
| 11 | | | 6 | |

* One at the epi-ceratobranchial joint is not counted. ½ signifies right or left side only.

even temporary picture of the fin formula in the Mungo and does not justify a subspecific name.

A female of 64 mm SL with ovarian eggs of 2·5 mm long diameter had a general dark olive colour with green iridescence on two longitudinal rows of scales above the level of the pectoral fin. The opercular spot was black with blue iridescence and this blue extended downwards on the opercular edge. The dorsal fin had the characteristic broad silver-bronze band and the spots on it were in one series. The lower lip was pale yellow and the leading edge of the pelvic iridescent light blue. The caudal was without spots. A male had a spotted caudal and the dorsal fin was pinkish without any iridescence.

### *C. g. loennbergi* (Trewavas 1962 : 160 *fig.* 4)

The narrower interorbital on which I relied for the distinction of the Kotto population in 1962 distinguishes the majority of our larger sample, but would hardly be enough to maintain even its subspecific rank without the supporting distinction of the lower number of epibranchial gill-rakers.

The general colour is paler than in the Mungo population, giving the impression of a yellow fish. The flanks vary from watery green to yellow, sometimes soiled with melanin.

There is a black opercular spot and the lower parts of the head are pale iridescent blue, the branchiostegal membrane white or pink. The chest is white (♀) or pink (♂) and the belly and lower parts of flanks are often tinged pink. The dorsal and caudal fins have yellow ground colour ; in mature fishes the upper edge of the soft dorsal and upper corner of the caudal are black with white submargin. The spinous dorsal of the female bears numerous small black spots in 1–3 irregular series or quite irregularly arranged, extending on to the soft dorsal ; in the sexually mature female these spots overlie a broad silver-bronze band extending along the whole of the spinous dorsal and the lappets are grey tipped with black. The male has neither the metallic band nor the black spots on the dorsal, but the soft dorsal may have faint spots that range from clear (on a yellow ground) to grey. The caudal is usually immaculate in females but spotted in males. The anal is grey, sometimes clouded

### TABLE 16

Dorsal fin-rays in populations of *Chromidotilapia finleyi* and *C. guntheri*

| | XIV 10 | XV 9 | XV 10 | XVI 9 | XV 11 | XVI 10 | XVII 9 | XVI 11 | XVII 10 | XVI 12 |
|---|---|---|---|---|---|---|---|---|---|---|
| *C. finleyi* | | | | | | | | | | |
| Mungo and Nganjoke | | 3 | 17 | 4 | | | | | | |
| *C.g. guntheri* | | | | | | | | | | |
| Mungo | 1 | | 23 | 4 | 2 | 4 | | 1 | | |
| *C.g. loennbergi* | | | | | | | | | | |
| Kotto and Nganjoke | | | | 2 | 1 | 7 | 4 | 1 | 1 | |
| *C.g. guntheri* | | | | | | | | | | |
| Ghana and Nigeria | | | | 1 | 7 | 7 | | 23 | 2 | 1 |

| | Total rays | | | | | Spines | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 24 | 25 | 26 | 27 | 28 | XIV | XV | XVI | XVII |
| *C. finleyi* | 3 | 21 | | | | | 20 | 4 | |
| *C.g. guntheri* | | | | | | | | | |
| Mungo | 1 | 27 | 6 | 1 | | 1 | 25 | 8 | |
| *C.g. loennbergi* | | | | | | | | | |
| Kotto and Nganjoke | | 2 | 12 | 2 | | | 1 | 10 | 5 |
| *C.g. guntheri* | | | | | | | | | |
| Ghana, Nigeria and Benito | | 1 | 14 | 25 | 1 | | 7 | 32 | 2 |

or washed pink. The pectoral is clear yellow. The pelvic is colourless in the ♀ with iridescent blue leading edge, in the ♂ pinkish grey with leading edge and a short filament white.

On narcotization or death a vague longitudinal dark band or series of blotches appears along each flank. There are some differences between this colour pattern and that described by Loiselle (1972a, b) for a Ghana population. He records a lateral longitudinal dark band in the living fish more regular and conspicuous than in either West Cameroonian population, a magenta ventral blotch in the female and carmine instead of black edges to soft dorsal and caudal fins. More surprisingly, an iridescent band along the dorsal fin appears in photographs labelled both male and female, whereas I (and others) have found it only in females. Also on the branchiostegal membrane and 'gular region' (= chest according to Loiselle *in litt.*) where I record a pink colour Loiselle records orange red, possibly a local or behavioural difference. Loiselle observed mature fishes in aquaria and so was able to see colour displays in life, and we did not.

The ecology of *C. g. loennbergi* is described by Corbet et al. (1973). The main food consists of chironomid larvae. The structures of mouth and pharynx concerned with feeding are described on pp. 389 - 391 of the present paper.

Two specimens were taken in R. Nyoke, which, although it flows past the crater of Barombi Kotto not more than half a mile away, has no connection with the lake or its outlet Nganjoke. Their upper gill-rakers and interorbital width are both in the overlap zone between *C. g. guntheri* and *C. g. loennbergi* and I cannot place them definitely in either. The types of *C. boulengeri* (Lönnberg) which in 1962 I synonymized with *C. guntheri* are respectively bigger (SL 110 mm) and smaller (SL 62 and 36·5 mm) than our Kotto samples. They have rather broad interorbitals, respectively 28·0, 25·8 and 25·0% length of head, and I counted the upper gill-rakers as 6, 8 and 9. Their status must await further knowledge as to how far in R. Meme the characteristics of the Kotto population extend. The part of the Meme that yielded these types is not recorded. If they belong to the Kotto population their name must replace *C. g. loennbergi*, but I have not at present enough evidence to make such a change.

### Distribution of *C. guntheri*

Samples in the BMNH range from Sierra Leone to R. Benito. Although some doubt has been thrown on the extreme records (Loiselle, loc. cit.) we have no reason to doubt them. Those from 'Murray Town, Sierra Leone' were collected by Mr P. Carmichael Lowe and registered in 1920. This expedition had as its main object the collection of birds and Sierra Leone is the only mainland territory from which Mr Lowe's birds and fishes of that date are registered. The species has not been subsequently collected in Sierra Leone.

Of the two specimens recorded from R. Benito (Boulenger, 1915 : 389 nos 28–29) one is *C. batesii*. The other is a male of 128 mm SL, bigger than all our specimens of

*C. kingsleyae*, the only other long-snouted species with which it might be confused. It differs from 7 specimens of *C. kingsleyae* from the Ogowe system (61–96 mm in SL) in the broader interorbital (27·5% length of head, cf. 19·6–23·8% in *C. kingsleyae*) and higher number of epibranchial gill-rakers (10, cf. 6–7 in *C. kingsleyae*) and seems to be a genuine *C. guntheri*.

Of two Kribi fishes listed as *C. kingsleyae* (reg. no. 1908.5.30.185–6) one is either *C. kingsleyae* or *C. guntheri*. It has the narrow interorbital of *C. kingsleyae* but a number of upper gill-rakers characteristic of *C. guntheri* (9 left, 10 right). Neither this nor the R. Benito specimen has any spots on the fins.

The evidence suggests that *C. guntheri* extends to R. Benito and *C. kingsleyae* takes its place in the Ogowe.

The upper Ogowe evidently contains other species of *Chromidotilapia* represented by the types of *Pelmatochromis regani* Pellegrin, 1907, and *P. haugi* Pellegrin, 1919a, which I have examined. Both are bigger than any *C. kingsleyae* in the BMNH and they have more lower gill-rakers, respectively 14 and 15 (cf. 9–11 in *C. kingsleyae*, but there are sometimes additional tubercles below them). *P. haugi* may be a synonym of *C. kingsleyae*, which it resembles in the long snout (49% length of head) and deep preorbital bone (28·6%). The bigger *P. regani* has a preorbital only about 25% of the head length and some of its pharyngeal teeth are enlarged.

## ***Tilapia camerunensis*** Lönnberg, 1903

*Tilapia lata* var. *camerunensis* Lönnberg, 1903 : 41.
*Tilapia lata* (part. nec Günther) ; Trewavas, 1962 : 166.

In 1962 I considered Lönnberg's type to be conspecific with the small specimen (SL 88·2 mm) that is the type of *T. lata* (Günther), but I now think that *T. lata* is a possible synonym of *T. guineensis* (Bleeker in Günther, 1862). The two names were proposed on the same page of Günther's *Catalogue*, *T. lata* from 'West Africa', *T. guineensis* from 'Ashantee'. Bleeker's specimens of *T. guineensis*, the type in Leyden and a specimen in the BMNH, are recognizable members of the lagoon populations of Ghana. The type of *T. lata*, less typical in shape, nevertheless has no feature that would exclude it from the same species as now understood, and since its type-locality is so vague there is every reason for adopting *T. guineensis* as the valid name, as has been done by Thys (1968b, 1971).

It seems possible, however, that the type of *T. camerunensis*, from 'high up in R. Meme', is conspecific with the Mungo population, and this is not *T. guineensis*. Our specimens were all young, collected by Dr Disney from R. Mungo : 1 of SL 35 mm, between Baduma and Bolo ; 6 of SL 42·5–75 mm from the bridge near Etam (BMNH 1973.5.14.1089–1095). We also have one of 135·5 mm collected by Mr David Blair in R. Blackwater (1973.5.14.1088). Lönnberg's type is 102 mm in SL.

Description of these specimens, with the figures for the type in brackets.

Depth of body 42·5–46·0 (46·5)% SL, length of head 32·8–35·0 (32), length of pectoral fin 31·5–33·0 (32·4), middle caudal rays 26–27 (25 ?).

Snout with straight or evenly decurved upper profile, 36·5–44·0 (44)% length of head, diameter of eye 24·5–37·5 (27·8), negatively allometric, depth of preorbital bone 20·5–27·0 (24·5), positively allometric, interorbital width 30·0–33·6 (33·8), length of lower jaw 34–39 (31).

Lower jaw falling a little short of upper in front. Teeth in 3 or 4 rows in upper jaw, a few of a 5th row in the largest, 3 rows in lower jaw, with a short 4th in largest; 24–46 (38) in outer series of upper jaw; outer stout, bicuspid with truncate major cusp, inner tricuspid.

Gill-rakers (2–3) + (0–1) + (8–9) on the first arch.

Lower pharyngeal bone stout, its width 37·2–38·7% length of head in two specimens of 75 and 64·5 mm SL respectively, with short blade and tricuspid posterior teeth (not examined in type).

Scales in 3 (3–4) rows on cheek, 29 (28 left, 29 right) in lateral line series, rather small on chest.

Dorsal XVI 11 (f.6) or XVI 12 (f.2 and type). Anal III 8 (f.3 and type) or III 9 (f.5).

Vertebrae 28, the modal number in *T.* (*Coptodon*). Mesethmoid meeting vomer in a brief suture on each side.

The Mungo specimens differ from *T. guineensis* of the lagoons of Ghana and Nigeria in the shorter pectoral fin and broader pharyngeal bone. The dorsal formula XVI 12 is fairly common in *T. guineensis*, but I have not found XVI 11 among 66 specimens from Lagos to Chiloango and Thys does not record it for this species in southern Cameroun. Neither is it recorded for *T. dageti* Thys, 1971, the species known to Daget (1954), Daget & Iltis (1965) and Blache et al. (1964) as *T. melanopleura*.

The dorsal formula distinguishes it too from *T. cameronensis* Holly of R. Sanaga. Among the 26 specimens described by Thys (1966) none has XVI 11 and only four XVI 12, and III 8 is a rare anal formula. This species also has a very broad lower jaw and the gill-raker numbers range higher. I have examined, as well as the holotype, four *T. cameronensis* from the Stanford University collection, all from R. Sanaga, and three of them have the modal dorsal formula given by Thys, XV 14, the fourth has XIV 14.

*T. kottae* differs from the Mungo samples in the fewer scales on the cheek and smaller pharyngeal bone as well as in colour, but XVI 11 is not an uncommon formula. *T. zillii* differs in the shape of head and body and usually has both horizontal and vertical stripes. *T. nyongana* Thys, 1971, though having meristic characters close to the Mungo samples, has a steep, straight profile from occiput to tip of snout and usually XV dorsal spines. Our living Mungo specimens were perhaps too young to have developed the silvery spots on the head characteristic of *T. nyongana* and there is no trace of them in the preserved adult. The geographical relation of the two populations, with *T. cameronensis* of R. Sanaga intervening, makes their identity unlikely.

The Mungo population of *T.* (*Coptodon*) has in fact its own characteristics and although it seems unwarranted to regard it as a species it is hard to say of which species it might be a subspecies. It is only tentatively bracketed with the Meme population as *T. camerunensis*.

### ***Tilapia kottae*** Lönnberg, 1904

Lönnberg, 1904 : 135 ; Boulenger, 1915 : 200 fig. 127 ; Trewavas, 1962 : 164.

Barombi names : fikunle (young), pindu (large specimens).

We collected the species only in the lakes, Barombi Kotto and Mboandong, where it was very abundant. Traps set in the streams near Kotto yielded *T. mariae* and *Chromidotilapia* but no *T. kottae*. Details of the ecology are given by Corbet et al. (1973).

The description given earlier (Trewavas, 1962) covers also the additional specimens, with slight extensions in the ranges of allometric characters corresponding to the further ranges of size. The length of the lower pharyngeal bone in 5 specimens of SL 95–113 mm is 24·0–25·5% length of head, its width 30·0–32·3, and the blade is 0·5–0·73 of the length of the toothed part. In a specimen of SL 68 mm the relative size of the bone is a little more, length 26·4%, width 36·2. Most specimens have only 2 rows of scales on the cheek, or at most an incomplete third row, in some on one side only.

Meristic characters, as might be expected in a restricted population, are very uniform, with narrow ranges and strong modes. The scales in the lateral line series number 29 in 17 of 21 specimens, 28 in 2, 30 in 2. There are 9 gill-rakers on the lower part of the arch in 10 of 14 specimens, and 8 anal soft rays in 13 of 14. The dorsal rays were counted in 29 specimens and gave a total of 27 in 22 specimens (XV 12 or XVI 11), 26 in 7 and 28 in 2.

Of the specimens analysed, 8 of SL 54·5–100·5 mm were females, 13 of 56·7–113·0 mm males. The gonads of the smallest ♀ were far advanced and a ♂ of 65 mm had enlarged testes. No differences were found between the sexes unless perhaps a filament terminating the pelvic fin is confined to larger males. Ripe eggs are pale olive-green (not yellow as found in preserved specimens in 1962), the biggest ovarian eggs seen having a long diameter of 1·8–2·0 mm.

Small individuals are yellow or olive-green, often with grey vertically elongate blotches along the middle of the flanks ; these may alternate with a more dorsal series of blotches or two of the latter may join with one of the former to give a dorsally forked bar (as in *T. ogowensis* and often in the young of other related species). Never was such a mid-lateral longitudinal band seen as is usual in *T. zillii*, nor a band punctuated with blotches as in *T. tholloni*. This vertical pattern is already present in fry of 15 mm and the breadth of the bars distinguishes them at sight from other species in Lake Kotto. The tilapia-mark in the young is round, intensely black, with a clear ring, bigger than in *T. mariae* or *S. galilaeus*. It persists until it is masked by the spread of melanin. From SL 24 mm upwards the throat, interoperculum and suboperculum and the sides of the chest become black, and blue iridescence sometimes seen on the gill-cover of the young soon becomes masked by melanin. Chest and belly may remain white or white unevenly soiled with melanin. The lower part of the flank may be pink.

Melanin extends all over the body and fins in bigger fishes, which have either a soiled appearance or are almost totally black, usually with a white lower lip and sometimes with the lappets of the dorsal fin yellow or orange. Upper and lower halves of the caudal may contrast in colour, but the colour varies, the upper half being pale yellow or with a pink reticulum enclosing watery green spots, the lower half yellow, soiled yellow or black ; or the whole fin may be covered more or less densely with melanin.

RELATIONSHIPS. Behaviour studies on species of *Tilapia* inspire caution in the use of the predominance of vertical or horizontal dark bands on the body as evidence of relationship (see especially fig. 1 in Voss, 1969). Yet the fact that in neither living nor preserved specimens did we see longitudinal bands, either continuous or represented by blotches on the vertical bars, differentiates it from *T. zillii* and *T. tholloni*, in which these are present. The rather big scales on the cheek, usually in only two rows distinguish it from *T. ogowensis* and *T. 'camerunensis'* and from the latter it also differs in colour, the more abruptly straight profile from snout to occiput and the usually smaller pharyngeal bone and thicker lips.

A species recently described by Thys (1972), *T. bemini*, from a crater lake draining to an upper tributary of the Cross River system, is, as Thys suggests, very similar in shape, meristic characters, thick lips, only two rows of scales on the cheek and yellowish colour, but in this the dentition of jaws and pharynx is more refined and only a few of the posterior pharyngeal teeth are tricuspid. These two species probably had a common ancestor at no very distant period, and this cannot have been very different from *T. camerunensis*.

ECOLOGY. Although *T. kottae* belongs to a section of the genus *Tilapia* whose relatively coarse dentition fits it to include vascular plants in the diet, Corbet et al. (1973) report that in Lake Kotto the main food consists of the phytoplankton in which this lake is very rich. This may be reflected in the slightly smaller pharyngeal bone of this species in comparison with *T. camerunensis*.

In Mboandong, where the phytoplankton is less dense, organic debris accounted for a bigger percentage of the stomach contents. Here, as in the case of many species of *Tilapia* and *Sarotherodon*, the young of SL 9–22 mm were more carnivorous than the adults (Corbet et al., loc. cit.).

MATERIAL PRESERVED

| BMNH register no. | SL (mm) | Locality |
|---|---|---|
| 1973.5.14.1117–1140 | 55–114 | Kotto, 1970 |
| 1973.7.18.219–258 | 11–39 | Kotto, 1972 |

## ***Tilapia mariae*** Boulenger, 1899

Boulenger, 1899 : 122 pl. xi fig. 1 (Niger Delta) ; Thys, 1966 : 36, pl. v and text-fig. 4 (Ivory Coast to South Cameroun).

*Tilapia microcephala* (nec Bleeker) ; Lönnberg, 1903 : 41 (R. Meme).

*Tilapia dubia* Lönnberg, 1904 : 137 (Barombi Kotto) ; Boulenger, 1915 : 189 (Kotto).

*Tilapia meeki* Pellegrin, 1911 : 185 ; id. 1914 : 63 pl. ii fig. 2 (Ivory Coast) ; id. 1928 : 9 (R. Sanaga).

*Tilapia heudeloti* (part. nec Duméril) ; Boulenger, 1915 : 175 (no. 34 only, R. Meme).

*Tilapia mariae dubia* (excl. syn. *T. haugi*) ; Trewavas, 1962 : 166 (Barombi Kotto).

Barombi name : finjongo.

I formerly (Trewavas, 1962) expressed doubt as to whether this population had more affinity with *T. haugi* (= *T. cabrae*) than with *T. mariae*. The discovery that sexually mature individuals of the Kotto population develop the characteristic lateral blotches of *T. mariae* (see R. A. Whitehead, 1962) confirms the action of Thys (1966) in putting the geographical boundary between the two species farther South. I also agree with him in abandoning trinominal nomenclature within this species, although the two features on which the subspecies *dubia* was maintained receive some confirmation from the new material.

*Interorbital width.* Table 17 shows different but overlapping ranges for this ratio in the Kotto and other populations, but the small numbers examined together with the allometry cast doubt on the significance of the difference. The values given by Thys (1966 : 37) for other localities in the Cameroons match better with my Kotto ranges than with those of western samples. Possibly there is a cline in this character.

*Pectoral fin.* Table 18 shows that although the pectoral lengths cover nearly the same range in and outside the Kotto population, 8 of the 9 specimens in which it is more than 38% SL are Kotto fishes. The range given by Thys for other specimens of Cameroun does not exceed 37·3%. Since the pectoral is probably used more in still than in flowing waters for keeping station and locomotion this is not an unexpected difference and may not be genetically based.

*Colour.* The colour-pattern, as R. A. Whitehead (1962) showed, undergoes a change from a series of dark vertical bands in the young to a series of up to six dark blotches along the middle of each side in the adult. According to Whitehead's

TABLE 17

*Tilapia mariae* : Interorbital width as % length of head in Lake Kotto and other localities

| | At SL 62–100 mm | At SL 101–150 mm |
|---|---|---|
| Barombi Kotto | 34·0–39·0 (*n* = 13) | 36·3–43·6 (*n* = 11)<br>Mean SL 111 mm |
| Other localities | 40·0–42·5 (*n* = 9) | 41·4–48·8 (*n* = 9)<br>Mean SL 128 mm |

TABLE 18

*Tilapia mariae* : Length of pectoral fin as % SL in Lake Kotto and other localities : frequencies

| % | Kotto | Other localities |
|---|---|---|
| 32·0 | 1 | 1 |
| 32·1–34·0 | 0 | 2 |
| 34·1–36·0 | 3 | 4 |
| 36·1–38·0 | 6 | 3 |
| 38·1–40·0 | 6 | 1 |
| 40·1–41·5 | 2 | 0 |

observations, the change is related to sexual maturity – he found both to occur at a smaller size in one of the localities studied by him than in the other.

Thys (1966) found in South Cameroun two types of adult coloration, one with dark blotches on a yellow ground, the other black. In Barombi Kotto both changes occur in the same individual, but not necessarily at the same time. The blotches, when they occur, alternate with the positions of the bands as can be seen in transitional cases where bands and blotches occur together. An uneven spread of melanin may leave bands still visible for instance on the lower half of the body, or may allow some blotches to be seen.

The following examples illustrate these changes. 'stg' signifies gonads just starting to swell, 'rpg' a later stage, in females with eggs not yet to definitive size, 'rp' with eggs at full size.

SL 91 mm ♀ rpg : 5 blotches between the fading bands.
SL 91·2 mm ♀ rp (eggs 2–2½ mm) : 4 incipient blotches between 2nd to 6th bands.
SL 102·8 mm ♀ rpg (eggs 1·5 mm, green) : 5 marked blotches on a green ground.
SL 105·5 mm ♀ rp : general dark colour, suggestion of three dark blotches on left side.
SL 116·0 mm ♀ rp (eggs partly discharged) : general very dark green colour, no bands or blotches visible.
SL 118·5 mm ♀ rpg : 4 bands on lower half of body.
SL 105·6 mm ♂ stg : vague grey bands on lower half of left side ; body green with bases of scales black.
SL 135·0 mm ♂, gonads small : six dark vertical bands.
SL 135·0 mm ♂, gonads small : vague traces of bands obscured by black to dark green.
SL 145·0 mm ♂ stg : bands on a green ground ; fins dark (after 2 days in formalin body all-black).
SL 150 mm ♂ : body and fins dark green to black.

Any more precise appraisal of the correlations must be based on more living material. Thys reports observations by Wickler that suggest a dependence of the blotch pattern on the assumption of territorial behaviour, and the association of the black colour with a non-sexual phase. The latter correlation is not supported by our observations on the Kotto samples.

However dark the fish may be, the upper edge of the soft dorsal and upper corner of the caudal are red or pink, sometimes briefly underlined with white or yellow. The dorsal lappets may have narrow pink or yellow edges.

The food of *T. mariae* in Lake Kotto consists mainly of phytoplankton (see Corbet et al., 1973) and this is not what would be expected from its dentition, which consists of several rows of spoon-shaped teeth, the outer with one notch, the inner with two. This is the typical equipment of an aufwuchs-grazer, which probably is *T. mariae*'s more usual role (cf. Fagade, 1971, on the population of Lagos Lagoon). As in the case of *T. kottae*, the unusual richness of Lake Kotto in phytoplankton has determined its special feeding habit.

We caught *T. mariae* in Lake Kotto and its outlet stream Nganjoke ; it is recorded from R. Meme. Its habitat throughout its range is in the fresh waters of the coastal plains and it is not surprising that it was not found in the upper Mungo, separated as this is from the coastal reaches by falls and rapids. Holly (1927b) reported it from R. Mbam, Sanaga system, much farther inland, but Thys (1966 : 42) has seen Holly's material and includes in *T. mariae* only the specimens from the lower Sanaga.

We have no information on breeding from this population (although it is now well documented from elsewhere). A single young of 16·5 mm SL caught in 1972 with young *T. kottae* at a beach at the perimeter of Lake Kotto was distinguished from other species by a gill-raker count of 12, very small notched teeth and the presence of seven faint vertical bars on the flanks some of which extended on to the dorsal fin (see also photograph by Marcuse, 1971).

MATERIAL PRESERVED

| BMNH register no. | SL (mm) | Locality |
|---|---|---|
| 1973.5.14.1097–1115 | 91–150 | Kotto |
| 1973.5.14.1096 | 115 | R. Nganjoke |

## *Sarotherodon galilaeus* (Linnaeus, 1758)

*Sparus galilaeus* Linnaeus, 1758 : 282 (Tiberias).
*Tilapia macrocephala* (nec Bleeker) ; Lönnberg, 1904 : 135 (Kotto).
*Tilapia galilaea* ; Trewavas, 1962 : 177 (Kotto).
*Sarotherodon galilaeus* Trewavas, 1973 : 23.

Measurements on 5 additional specimens from Barombi Kotto and 4 from Mboandong confirm the observation of 1962 that the depth of body in this population is less than the average – 35·0–46·5% SL (in other populations sampled, except one, 43·5–56·0%). The meristic characters associated with the metameres are in agreement with those of other West African populations (excluding *S. g. multifasciatus*), namely, vertebrae 29 in all (mode in West Africa and Lake Albert 29, in the Jordan Valley and other rivers of Israel 30) ; scales in lateral line series 30 (f.6) or 31 (f.4) (mode in West Africa and Lake Albert 30, in Asia and the Nile 31) ; total dorsal rays 27 (f.2) or 28 (f.7) (mode in West Africa and Lake Albert 28, in Asia and the Nile 29).

The colour in adults is pale brassy yellow, white ventrally. The discontinuous vertical bands that are present in individuals of all populations, and, as students of behaviour have shown, possibly in all individuals in certain emotional states, are absent from most of our specimens, but traces of them are present in three. A juvenile of SL 69·5 mm had after preservation the fainter, more continuous grey vertical bands common in juvenile *Sarotherodon* and a faint tilapia-mark.

The fins were almost colourless, but in a favourable light the soft dorsal was seen to have pale yellow spots on a pale grey ground. The pelvics were faintly tinged with orange and their leading edge and short filament were white.

The juvenile of 69·5 mm was silvery instead of yellow.

Other proportions and structures are as in other populations of *S. galilaeus*, including the pharyngeal bones, which are no smaller than elsewhere (cf. 'slightly smaller', Trewavas, 1962). I do not find any justification for considering this population a distinct subspecies. It differs from most others in the more slender body, but the *S. galilaeus* of Nungua Reservoir, near Accra, are also relatively slender (depth 38–49% SL) and the difference is no more than might be attributed to 'condition' – although I do not suggest that either population is underfed.

Neither do I think it useful to use a subspecific name to distinguish the West African populations from those of the Nile and the Jordan Valley. Schultz (1942) and Thys (1969, 1971) have used *pleuromelas* Duméril in this sense at specific or subspecific level without giving any distinguishing characters. Although the modal numbers of vertebrae, scales and dorsal rays are one less in West Africa than in Asia and the Nile, the lower modes are also those of the small Lake Albert sample available (15 specimens). Biparental mouth-brooding is now known to be practised by the species in West Africa as well as in the Jordan Valley (Iles & Holden, 1969). The present geographical gap between the Nile and Chad populations is evidently a recent one – *S. galilaeus* is present in Jebel Marra between Chad and the White Nile and in R. Draa, north of the Sahara.

It is natural to compare the Kotto *S. galilaeus* with those of R. Sanaga, Cameroun, named *T. sanagaensis* by Thys in 1966. This was distinguished by the blue-grey to purplish colour of the dorsum and the series of clear round spots on a background of the same colour on the dorsal and caudal fins. From the description I have given of the Kotto colouring it is plain that the basis of this colour-pattern is there too, but lacks the contrast given in the Sanaga by the darker ground colour.

The figure of the type given by Thys (1966, pl. i) shows a very *galilaeus*-like facies. But the head in this fish, and also in one from R. Lom (tributary of Sanaga) in the BMNH, is relatively small – 32% SL, the lowest ratio in any *S. galilaeus* seen by me. Holly (1927b : 220) obtained the same ratio in specimens from R. Mbam. The head length in Thys's seven specimens, however, ranged to 35·5%, in Sanaga fishes seen by me to 34·5%. The range in Kotto and Mboandong is 35–37%. Elsewhere, even among topotypes of *S. galilaeus*, the lower limit of the ranges is 32·5%, so a small head seems a character of doubtful taxonomic significance.

I do not doubt that the Sanaga population has its own characteristics, and I note Thys's report that it retains its distinctive colour vis-à-vis others imported to the same ponds from Ubangi-Chari, but I doubt if any useful purpose can be served by naming it. However that may be, the Kotto population does not share these peculiarities and I would retain the latter in *S. g. galilaeus*.

This species was caught by fishermen with cast-nets in the open water and not (except young) in traps set at the shore. We found no brooding individuals. Ripe ovarian eggs were olive-green. The food, mainly phytoplankton, is described by Corbet et al. (1973).

Professor Green and Dr Corbet caught numerous young of 21–37 mm SL at the landing beach of Kotto Island in 1972. Like many young *Sarotherodon*, these are as deep-bodied as the adults (depth 39–47% SL). The teeth, smaller than in *T. kottae* of the same size, are triangular in shape with the apex of the triangle at the attached end and the free edge divided by a notch. Dorsal fin-rays, counted in eight, number 27 in seven (XV 12 or XVI 11), 26 (XIV 12) in one. A small but distinct tilapia-mark is present and the edges of the vertical fins are narrowly black (preserved specimens). Faint grey vertical bars are present on the flanks.

MATERIAL PRESERVED

| BMNH register no. | SL (mm) | Locality |
|---|---|---|
| 1973.5.14.779–782 | 122–145 | Mboandong |
| 1973.5.14.783 | 69·5 | Kotto, 1970 |
| 1973.7.18.173–196 | 21–38 | Kotto, 1972 |

## ZOOGEOGRAPHICAL SUMMARY AND CONCLUSIONS

In the neighbourhood of the three lakes of West Cameroon visited by our expedition the streams of the Mungo and Meme systems are not far apart and even interdigitate in this very uneven territory, whose topography is the result of vulcanism from the middle Tertiary to the present day. River-capture in the upper streams is readily understandable, and Barombi Mbo, whose present outlet is to the Mungo, is believed formerly to have drained to the Meme (Dusen, quoted by Trewavas, 1962 : 150). The stream Nyoke, from which villagers living close to the Kotto crater get their drinking water, is a tributary of the Mungo, although Lake Kotto drains to the Meme. The southern sources of the Cross River system are not far from the sources of the Mungo and there is evidence of faunistic relationship with them, but our knowledge of the Cross fauna is too incomplete to contribute much to the present conclusions.* Topographically therefore we have good reason to treat the Mungo and Meme systems together and although our sampling of the Meme system was confined to Lake Kotto, its outlet Nganjoke and an upper tributary, R. Billé, there is some justification in treating them as a faunistic unit too.

Consideration of the list of Mungo–Meme fishes prompts certain comparisons :

(1) Comparison of our upland collection with a small collection of fishes made near the mouth of the Mungo by Mr Deveson in 1951 and 1952.

(2) The relationship of the Mungo–Meme fauna to that of Fernando Poo.

(3) The relationship of the fauna of the rivers to those of the three lakes.

(4) The relationship of the Mungo–Meme–Fernando Poo fauna to that of the rest of West Africa.

(1) Mr Deveson's collections were made in the neighbourhood of Tiko and his biotopes included both still waters and streams with a considerable current. A list of his species follows with the relevant parts of his field notes.

a. Species also present in our collections.

*Brienomyrus brachyistius* (or *longianalis* ?) : in rapid water under shelter of rocks and weeds at side of river ; in loose shoals of about 20 fishes.

*Alestes longipinnis* : in open water with a current.

*Barbus thysi* : in water flowing at about 6 knots.

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* In the mainstream of the Cross River marine and brackish water species extend inland as far as the neighbourhood of Bambui. Messrs J. Grimshaw and L. Torrans, American Peace Corps workers in the region, showed me specimens of *Pomadasys jubelini* and *Trachynotus goreensis* collected there.

*Epiplatys sexfasciatus*: common in rivers and agricultural drains; seemed to prefer more acid waters than other species collected.

*Chromidotilapia guntheri*: in long grass on flooded land.

*Hemichromis fasciatus* (or *elongatus* ?): in both still and running water, acid or alkaline.

b. Species not in our collections and not recorded from Fernando Poo.

*Nannaethiops unitaeniatus*: in a forest stream, tributary of R. Matute, spaced along stream with no sign of shoals.

*Hemichromis bimaculatus* Gill: ecology as *H. fasciatus.*

*Ctenopoma kingsleyae* (Günther): in still, sheltered parts of small rivers; feeds on surface insects and comes to surface for air.

*Channa obscurus* (Günther): found in flooded grasslands.

The species common to both collections were found in biotopes similar to those in which we caught them, except that *C. guntheri,* which we found to be the more adaptable of the two species in the Mungo, was found in a biotope not encountered by us. *Ctenopoma* and *Channa* are adapted to lowland swamps liable to oxygen deficiencies. In the lowland forest streams near Douala Thys (1967 : 139) also reports these two as well as *Calamoichthys calabaricus.* The basis of selection of biotopes by *Nannaethiops* and *Hemichromis bimaculatus* is unknown to me.

(2) In his analysis of the freshwater fish fauna of Fernando Poo, Thys (1967) places twelve species in his group A, true freshwater fishes with little or no salt tolerance in nature. *All of these are present in our Mungo–Meme collections.* Although three of Thys's identifications have since been corrected, the new names are here held to apply also to the respective Mungo populations (*Barbus thysi, Aphyosemion oeseri* and *Chromidotilapia finleyi*). The question has been raised (p. 397) of the possible subspecific distinctness of the island *Chromidotilapia*; and the specific identity of the Mungo *A. oeseri* with the type population of the island may with advantage be further tested; but the relationships are at any rate very close. Emphasizing the identity of the island and mainland faunas is the apparent restriction of two species, *A. oeseri* and *B. thysi* (but see p. 352) to Fernando Poo and the Mungo and Meme basins.

(3) *Kotto and Mboandong.* Eleven species were found within the crater of Kotto. Four of these, the cyprinodonts *E. sexfasciatus, A. bivittatum, A. oeseri* and *Procatopus* sp. were caught by us only in the inflowing streams. The others were *Barbus callipterus, Clarias walkeri* and the five Cichlidae, including the endemic subspecies *C. guntheri loennbergi* and *T. kottae,* endemic to this and the small lake Mboandong. From what has been written on p. 405, it will be seen that I consider it possible that *T. kottae, T. camerunensis* and *T. bemini* form a group of taxa (species ?, subspecies ?) peculiar to the Mungo, Meme and Cross systems. *T. mariae* is a freshwater *Tilapia* abundant in the lower reaches of river systems from South Cameroun to Western Nigeria and again in Ivory Coast, in the forest zone. It was caught in both Kotto and its outlet. *Sarotherodon g. galilaeus* is not recorded elsewhere in Cameroun, the population of R. Sanaga being sufficiently distinct from it to have been regarded as another species. Adults were caught in the open water of both lakes and young around the margins. The widespread *Hemichromis elongatus* has flourishing colonies

in both Kotto and Mboandong. With *T. kottae*, it lives near the edges of Mboandong, and here too are abundant *A. bivittatum* and *A. oeseri*. The rim of this shallow lake with its carpet of fallen leaves and its constant rain of terrestrial insects resembles a forest stream and it occurred to us that *S. galilaeus*, so untypical of such an environment, might have been stocked there from Kotto. It was being caught by cast-nets.

To summarize, the fish fauna of Lake Kotto shows no endemism that on structural grounds can be considered to extend beyond the subspecific level (except possibly *T. kottae*). It is a part of the Mungo–Meme fauna whose members are well fitted to take advantage of the eutrophic ecology of Lake Kotto.

*Mbo* (see Trewavas et al., 1972). Thys estimates (1937 : 135) that the Fernando Poo fresh waters have been effectively isolated from the mainland for 8000–10 000 years. Unfortunately I know of no evidence for the date at which the crater of Barombi Mbo was formed or when volcanic disturbance within it last exterminated life in its waters. But the contrast between the extreme endemism of Barombi Mbo and the non-endemism of the Fernando Poo fish fauna can hardly be explained by differences in the degree or time of isolation, both of which may well be less for the lake than the island.

The contrast is associated with two facts :

(1) The ecology of the fish biotopes in the island is identical with that of the Mungo–Meme tributaries – hilly forest streams – that of the lake is contrasted.

(2) The lake was colonized by members of the family Cichlidae, a family represented by only one species on the island, and that preadapted for the island biotopes. To say that the Cichlidae are notoriously able to adjust their feeding and reproductive habits to a lake environment is of course only to push the question farther back.

Our comparison of the Mbo fauna has been mainly with that of the neighbouring Mungo streams, but the possibility that Mbo formerly drained to the Meme reminds us that the Kotto section of the Meme fauna includes two possible ancestors of Mbo cichlids, *T. mariae* and *S. galilaeus*.

*Soden*. Of the four species present in this lake, *Barbus batesii* and the *Clarias* are members of the Mungo–Meme fauna with population characteristics peculiar to the lake. *Aphyosemion celiae* relates the lake fauna to that of the Upper Mungo, but further exploration of the Meme may discover it there too. The special ecology of *Procatopus lacustris* may be made possible by the absence of competitors, though probable predators (*Barbus* and *Clarias*) are present.

(4) Table 19 provides a conspectus of the distribution of the species of the Mungo–Meme fauna as far as present knowledge will take us. Leaving out of account the ten widespread species that head the list, it is clear that the fishes of West Cameroon belong to the fauna of the coastal forest belt from South Cameroun to Lagos. The emphasis is on South Cameroun – note especially that the section of the genus *Auchenoglanis* to which our species belongs is not reported West of the Cameroons. Since we expect our knowledge of Cameroun fishes soon to be extended by the work of Dr Thys van den Audenaerde it would be premature to go into further details.

The small number of species common to our area and the Chad basin supports the increasingly recognized division between forest and savannah fish faunas in West Africa.

TABLE 19

Known distribution of the species of freshwater fishes found in the Mungo and Meme systems, excluding the lakes

| Localities<br>Species | Co | Ch | Ga | RM | SC | WC | FP | Ng | La | Da | To | Gh | Iv | Li | SL | Gu | Gm | Se | UN | Cd | Nil |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *M. electricus* | · | · | · | · | · | · | · | · | · | · | · | · | · | · | · | · | · | · | · | · | · |
| *H. fasciatus* and *H. elongatus* | · | · | · | · | · | · |  | · | · | · | · | · | · | · | · | · | · | · | · | · | · |
| *H. bimaculatus* | · | · | · | · | · | · |  | · | · | · | · | · | · | · | · |  | · |  | · | · | · |
| *S. galilaeus* | · |  | · |  | · | · |  | · | · | · | · | · | · | · |  | · | · | · | · | · | · |
| *C. obscurus* | · | · | · | · | · | · |  | · | · | · | · | · | · | · | · | · | · | · | · | · | · |
| *A. macrolepidotus* | · |  | · | · | · | · |  | · | · | · | · | · | · |  | · |  | · | · | · | · | · |
| *A. longipinnis* | · | · | · | · | · | · | · | · | · | · | · | · | · | · | · | · |  |  |  |  |  |
| *Ct. kingsleyae* | · | · | · |  |  | · |  | · | · | · |  | · | · | · | · | · | · | · | · |  |  |
| *B. brachyistius* |  |  | · | · | · | · |  | · | · |  |  | · | · | · |  |  | · |  |  |  |  |
| *C. guntheri* |  |  |  | · | · | · |  | · | · | · | · | · | · |  | · |  |  |  | · |  |  |
| *B. callipterus* |  |  |  |  | · | · | · | · |  |  |  | · | · |  |  |  |  |  | · | · |  |
| *B. mungoensis*, etc. |  |  |  |  | · | · |  |  |  |  |  | · | · |  |  |  |  |  | · | · |  |
| *T. mariae* |  |  |  | · | · | · |  | · | · |  |  |  | · |  |  |  |  |  |  |  |  |
| *E. sexfasciatus* |  | · | · | · | · | · | · | · | · |  | · |  |  |  |  |  |  |  |  |  |  |
| *A. bivittatus* |  |  |  | · | · | · | · | · | · |  | · |  |  |  |  |  |  |  |  |  |  |
| *B. camptacanthus* |  | · | · | · | · | · | · | · |  |  |  |  |  |  |  |  |  |  |  |  |  |
| *B. batesii* |  |  |  |  | · | · | · |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| *Procatopus* spp. |  |  |  |  | · | · | · | · | · |  |  |  |  |  |  |  |  |  |  |  |  |
| *M. tapirus* |  |  |  |  | · | · |  |  |  |  |  |  |  | · |  |  |  |  |  |  |  |
| *Auchenoglanis* (pt) | · |  | · | · | · | · |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| *Chi. micropogon* | · |  |  |  | · | · |  |  |  |  |  |  |  |  |  |  |  |  | · |  |  |
| *Cl. walkeri* |  |  |  | · | · | · | · |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| *C. finleyi* |  |  |  |  | · | · | · |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| *L. camerunensis* |  |  |  |  |  | · |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| *B. thysi* |  |  |  |  |  | · | · |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| *A. oeseri* |  |  |  |  |  | · | · |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| *A. celiae* |  |  |  |  |  | · |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| *Chi. disneyi* |  |  |  |  |  | · |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| *T. camerunensis* |  |  |  |  |  | · |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

The names of the localities are abbreviated as follows: Congo basin (Co), Chiloango (Ch), Gabon (Ga), Rio Muni (RM), South Cameroun (SC), West Cameroon (WC), Fernando Poo (FP), Niger delta (Ng), inland from Lagos (La), Dahomey (Da), Togo (To), Ghana( Gh), Ivory Coast (Iv), Liberia (Li), Sierra Leone (SL), Portuguese Guinea and Guinée (Gu), Gambia (Gm), Senegal (Se), Middle and Upper Niger (UN), Chad basin (Cd), Nile (Nil).

In some cases supraspecies or taxa bigger than species are used, as follows: *Hemichromis fasciatus* and *H. elongatus* are treated together; *H. bimaculatus* includes two species with broadly the same distribution; *S. galilaeus* includes its subspecies; *B. mungoensis* etc., means the West African species of *Barbus* with the last simple, stiffened ray as long as or longer than the head, including *B. mungoensis*; *Mormyrus tapirus* includes *M. goheeni*; the whole genus *Procatopus*, including subgenus *Andreasenius*, is included because of the unsatisfactory state of the taxonomy of that genus; only those species of *Auchenoglanis* are included that have the interneural plate in front of the dorsal fin hidden beneath the skin and not meeting the occipital process. Some of the widespread species occur also outside the areas considered.

## ACKNOWLEDGEMENTS

The visit to Cameroon in 1970 with Drs S. A. Corbet, J. Green and J. Griffith was financed by grants from the Royal Society, the Central Research Fund of the University of London and the Godman Exploration Fund and I should like to renew my thanks to these and to the members of the Helminthiasis Research Unit at Kumba for all the help they gave us.

I have had the benefit of all the resources available at the British Museum (Natural History) for statistical advice (Dr M. Hills), radiography (Mr G. Howes), microscope sectioning (Mr D. Cooper), alizarin preparations (Mr J. Chambers), photography (Mr P. A. Richens and Mr J. V. Brown) as well as of its incomparable library and collections.

As already stated in the Introduction, most of the fishes of the Mungo tributaries were collected by Dr R. H. L. Disney, who also provided the model for the sketch map (Fig. 1). On the enigmatic species of *Labeo* I have had the benefit of discussions with Mr Gordon Reid, a newcomer to taxonomy ; and I thank Dr Mary Whitear for an interesting discussion on histology.

The drawings for Figs 6, 7, 8, 9, 11 and 17 were made by Sharon Chambers. Mr E. Finley kindly provided the colour-photograph of Pl. 5.

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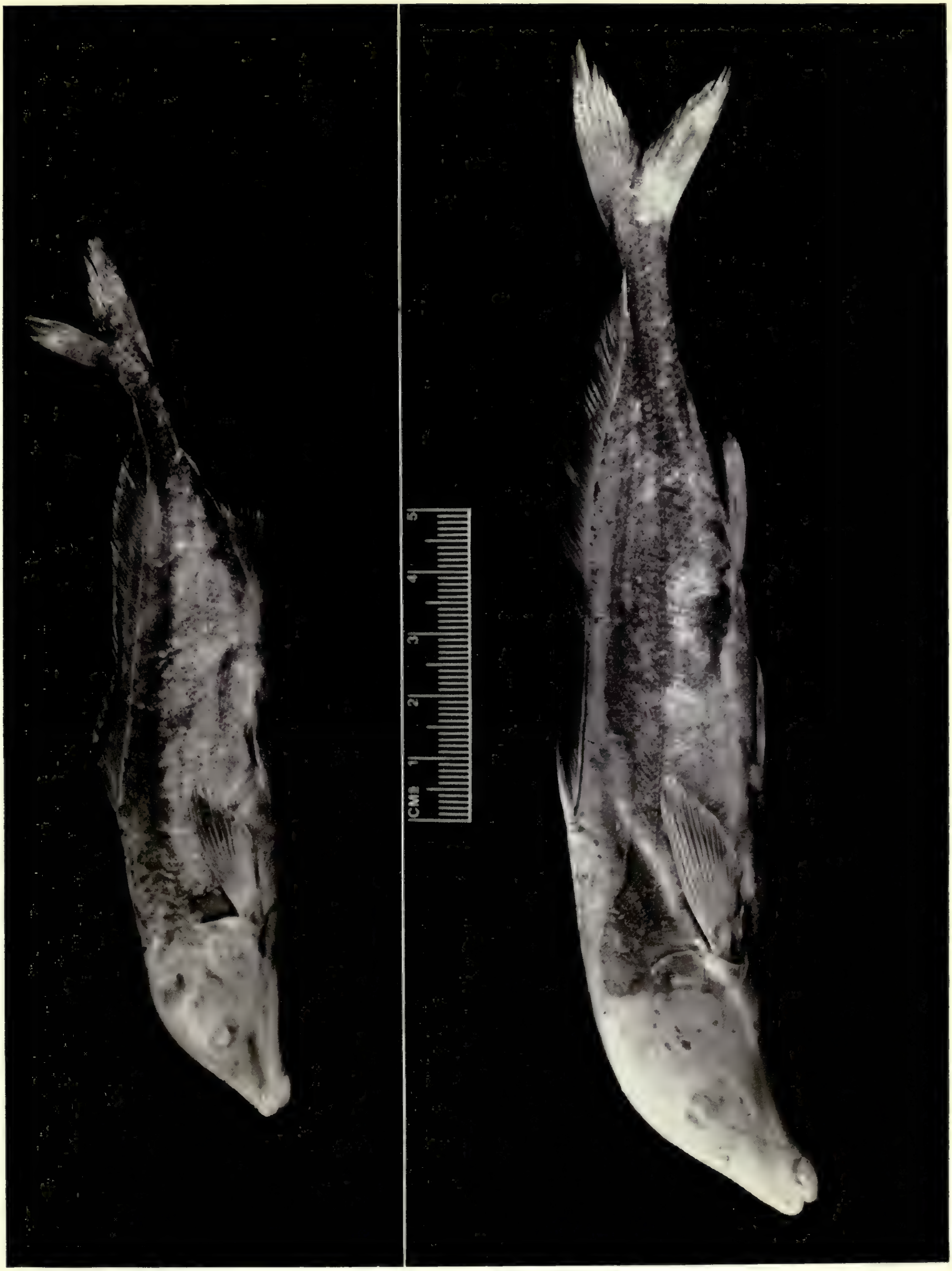
## PLATE I

*Mormyrus tapirus*, two specimens respectively 132 and 173 mm in SL from R. Wowe.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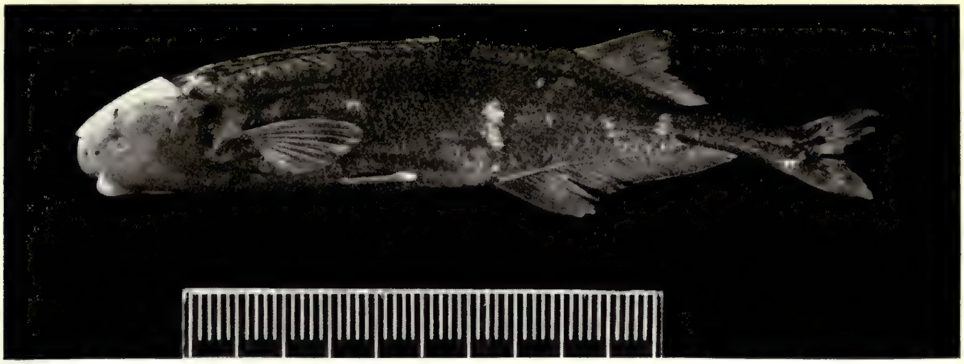
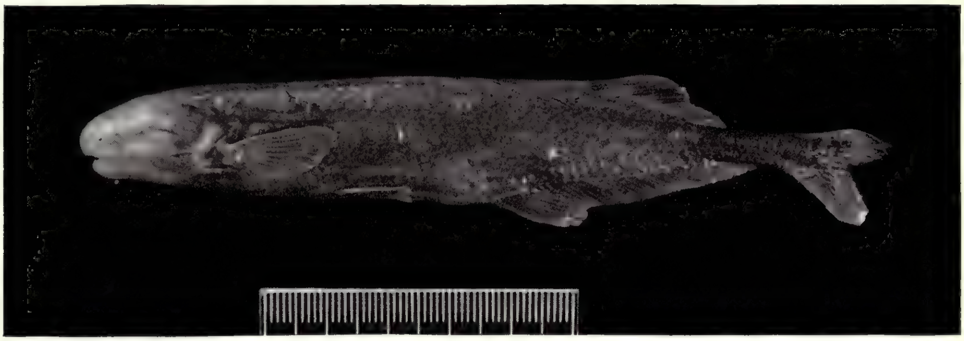
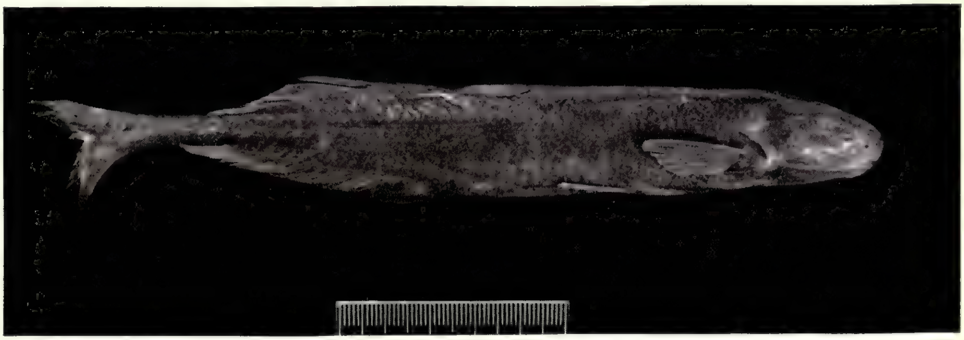
## PLATE 2

*Brienomyrus brachyistius.* A, B and C from R. Mungo, near Etam ; D from R. Nganjoke. The standard lengths are, A 78·5 mm, B 119 mm, C 174 mm and D 156 mm. Although the length of the Nganjoke fish, D, is between those of B and C, its shape is nearer that of the much smaller specimen, A. In A the epidermis of the top of the head has become detached.







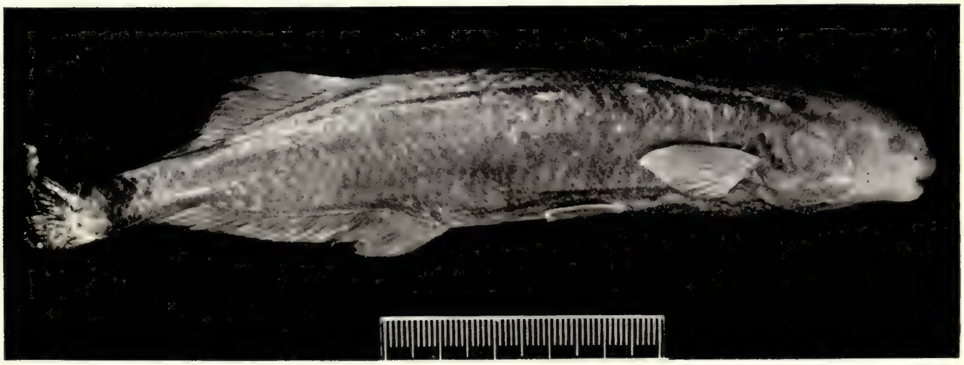
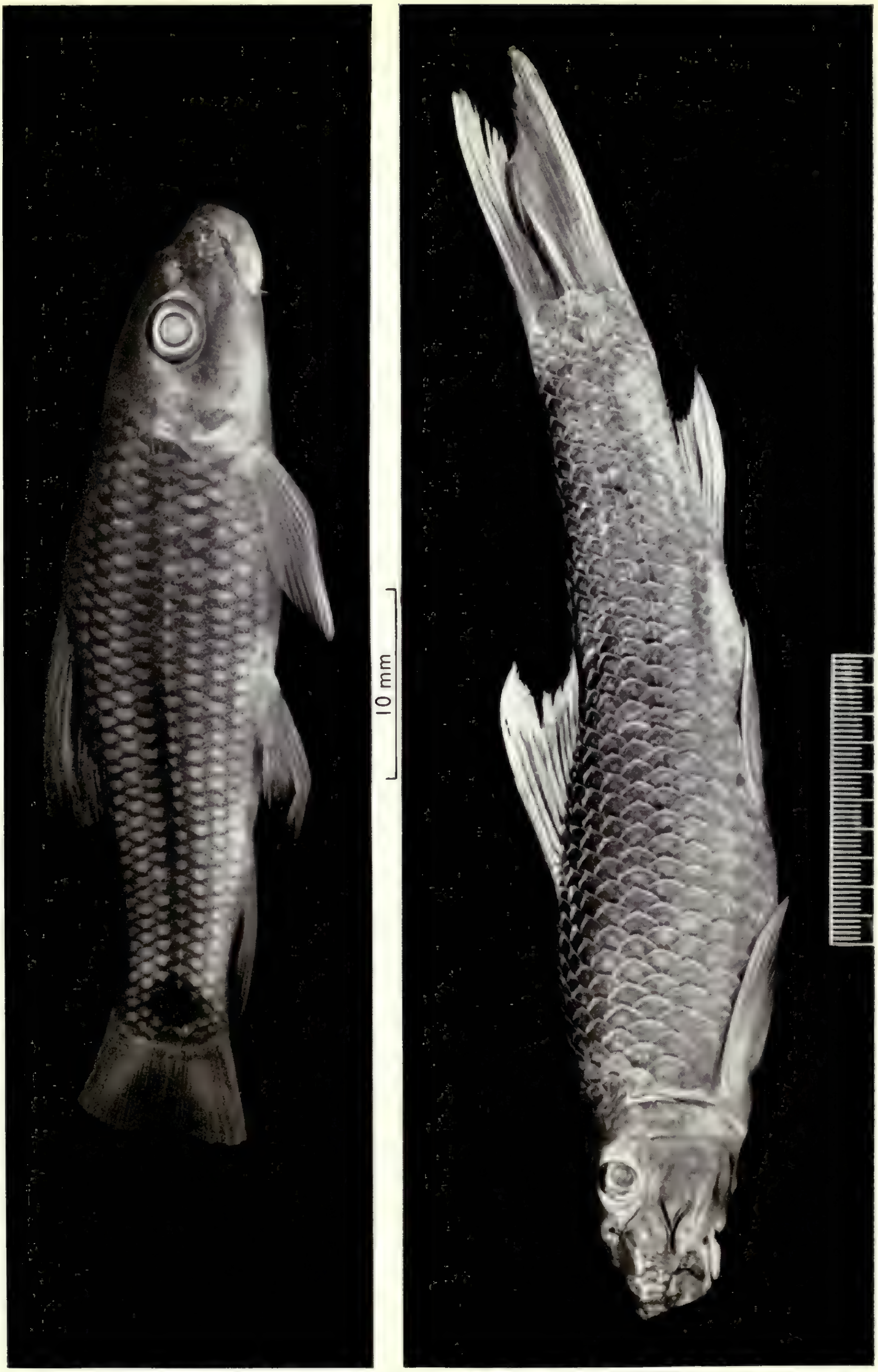


PLATE 3

*Labeo camerunensis,* paratypes (adult and young).


10 mm

## PLATE 4

Sections through the pharyngeal pad of, A and B, *Chromidotilapia g. loennbergi* and, C and D, *Tilapia mariae.* In A and B a hillock bearing taste buds is seen at different magnifications. In A some small mucus-cells can be seen near the surface of the epithelium. C and D are different parts of the same pad ; in C two taste buds have been grazed, in D one, but the most noticeable elements are the deep secretory cells that occupy the greater part of the epithelium.

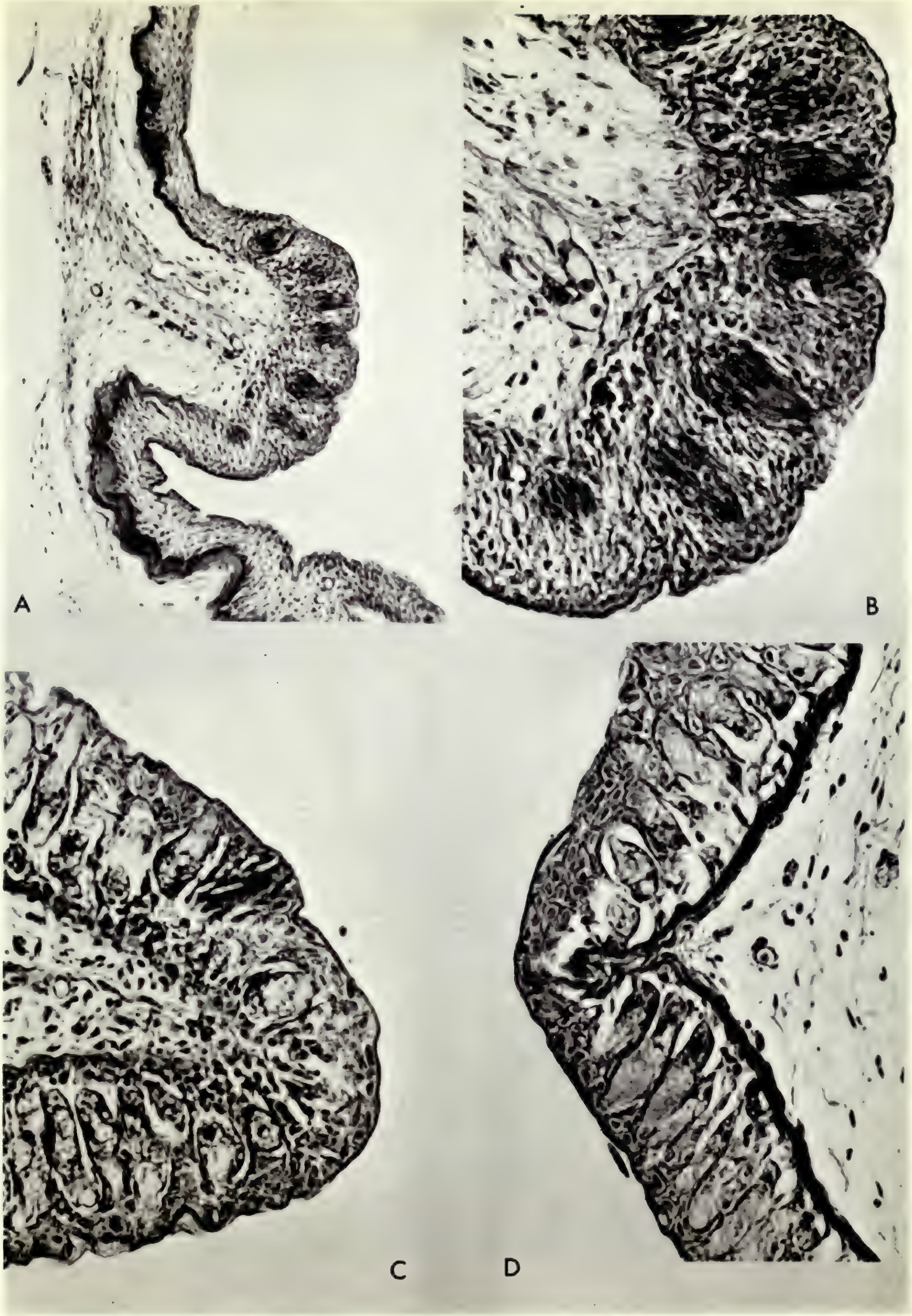
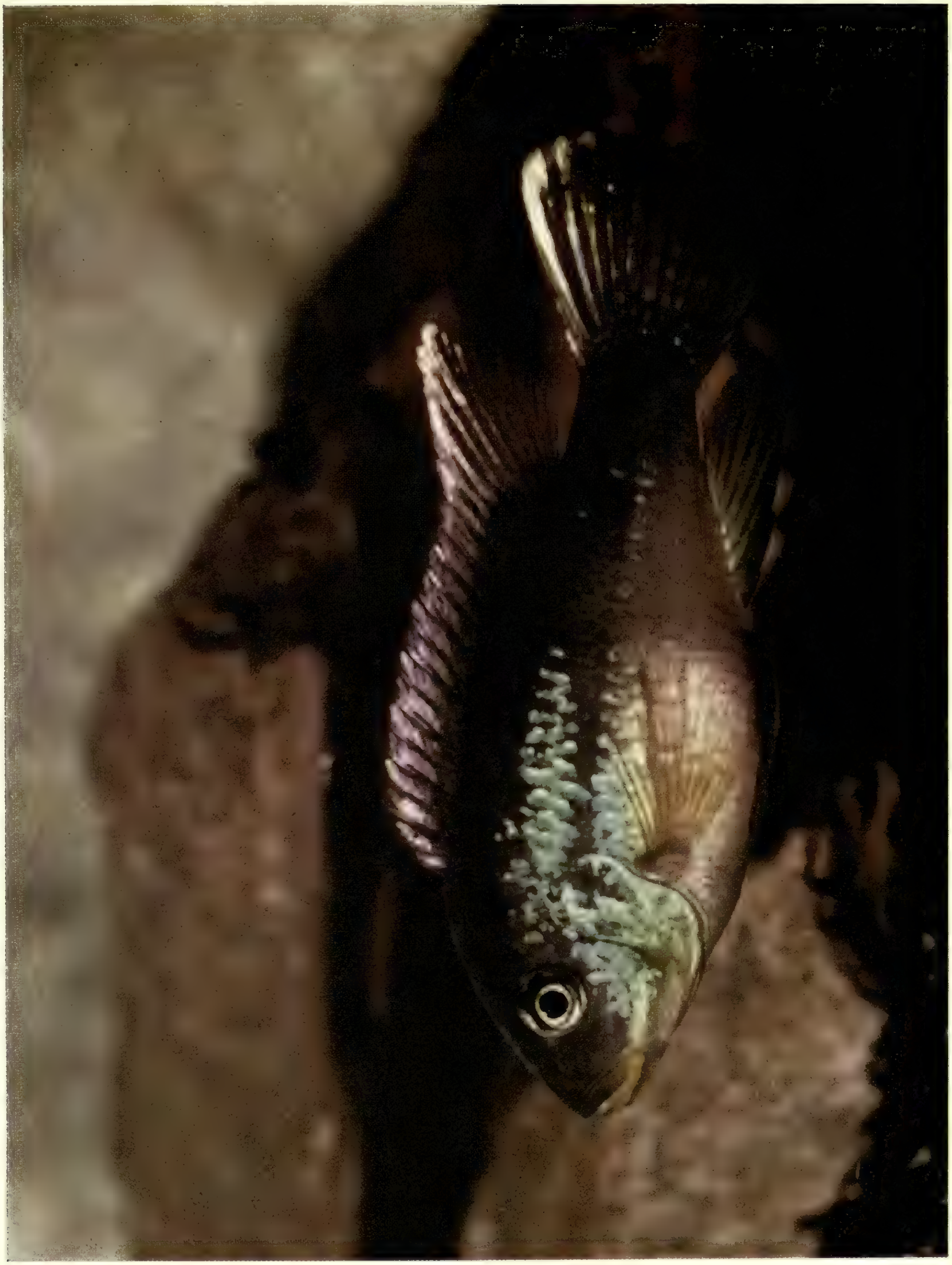

A
B
C
D

PLATE 5

*Chromidotilapia finleyi*, female. Photograph by Mr Lee Finley of Bridgeport, Conn., U.S.A. The specimen was taken within a 24 km radius of Kumba and belonged to Mr Ray Heimbuch of Westhaven, Conn.



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NATURAL HISTORY

# NOTES ON SOME ECHINODERMS FROM SOUTHERN AFRICA

A. M. CLARK

BULLETIN OF
THE BRITISH MUSEUM (NATURAL HISTORY)
ZOOLOGY Vol. 26 No. 6
LONDON : 1974

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# NOTES ON SOME ECHINODERMS FROM SOUTHERN AFRICA

BY
AILSA M. CLARK

*Pp. 421–487* ; 3 *Plates* ; 16 *Text-figures* ; 1 *Map* ; 3 *Tables*

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*World List* abbreviation :
*Bull. Br. Mus. nat. Hist.* (Zool.)

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THE BRITISH MUSEUM (NATURAL HISTORY)

*Issued 7 June,* 1974 *Price* £3.40

# NOTES ON SOME ECHINODERMS FROM SOUTHERN AFRICA

*By* AILSA M. CLARK

## SYNOPSIS

The main part of this paper deals with noteworthy species of echinoderms (excepting holothurians) from around the mainland of southern Africa south of the Tropic of Capricorn, with appendices on a few species from off-lying localities including the Vema Seamount, Walter's Shoal, a peak of the South-West Indian Ocean Ridge and Madagascar. Most of the specimens came from the Ecological Survey of the University of Cape Town but some were collected in conjunction with the International Indian Ocean Year, notably by the 'Anton Bruun'; a few from the British Museum collections are also dealt with. Three new species of ophiuroids are described and the ranges of four other ophiuroids and two unstalked crinoids are extended to southern Africa. A lectotype is selected for *Astropecten granulatus natalensis* John and taxonomic changes are made to several nominal species of other Asterozoa, including transfers to different genera, alterations in rank and synonymies (see p. 483).

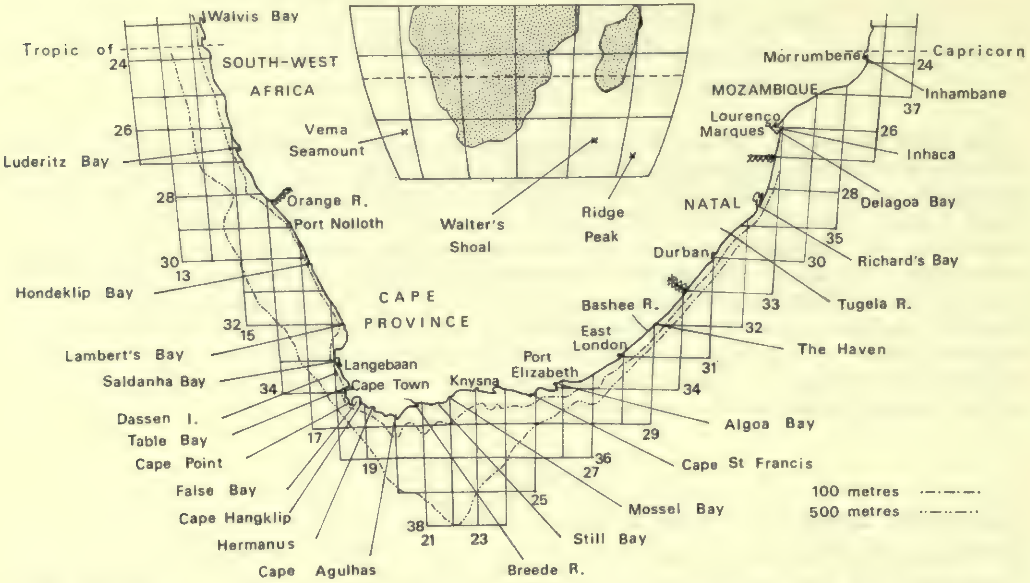
## INTRODUCTION

THIS paper brings up-to-date details of noteworthy echinoderms (excepting holothurians) collected since I last reported on South African echinoderms in 1952 by Professor J. H. Day and his co-workers at the University of Cape Town during their long-term Ecological Survey of South African and adjacent waters. Following the exhaustive studies of H. L. Clark (1923) and Mortensen (1933) it is not surprising that only three undescribed species – all ophiuroids – were found. Tantalizingly, no further material came to light of some of the little-known species such as the crinoids *Decametra durbanensis* A. M. Clark and *Monachocrinus perrieri* (Koehler and Vaney), the asteroids *Tethyaster pacei* (Mortensen) (originally *Anthosticte pacei*), *Ceramaster trispinosus* H. L. Clark, *Anseropoda novemradiata* (Bell) and *Mithrodia gigas* Mortensen, or the ophiuroids *Amphiura acutisquama* A. M. Clark, *A. linearis* Mortensen, *Ophiogymna capensis* (Lütken) and *Ophioderma wahlbergi* Müller and Troschel.

The main part of the text deals with specimens from around the mainland of southern Africa south of the Tropic of Capricorn (c. 23½° S), which just extends to include Inhambane in Mozambique on the east coast but not quite to Walvis Bay in South-West Africa on the west. There are six species new to the area, the crinoid *Oligometra serripinna* (P. H. Carpenter) and the ophiuroids *Anamphiura valida* H. L. Clark and *Amphiophiura trifolium* Hertz extending to Natal from Mauritius, the Amirante Islands, the Zanzibar area and Mombasa respectively, while the crinoid *Tropiometra magnifica* A. H. Clark with the ophiuroids *Ophiocirce inutilis* Koehler and *Ophiopallas paradoxa* are extended to southern Mozambique from localities further north in East Africa.

Since this paper went to press I have received from M. Jangoux a copy of his important paper 'Les Astéries de l'Ile d'Inhaca (Mozambique) (Echinodermata, Asteroidea). 1. Les espèces récoltées et leur répartition géographique.' *Ann. Mus. R. Afr. Cent.*, ser. 8°, Zool. No. 208: 1–50, 13 figs., 7 pls.

In addition, a few specimens from the off-lying Vema Seamount, Walter's Shoal, Madagascar and the South-west Indian Ocean Ridge are dealt with in appendices.


Walvis Bay
Tropic of
Capricorn
SOUTH-WEST
AFRICA
Vema
Seamount
Luderitz Bay
Orange R.
Port Nolloth
Walter's
Shoal
Ridge
Peak
Hondeklip Bay
CAPE
PROVINCE
Lambert's Bay
Saldanha Bay
Langebaan
Cape Town
Knysna
Port
Elizabeth
Dassen I.
Table Bay
Cape Point
False Bay
Cape Hangklip
Hermanus
Cape Agulhas
Breede R.
Still Bay
Mossel Bay
Cape St Francis
Algoa Bay
East
London
Bashee R.
The Haven
Durban
Tugela R.
Richard's Bay
NATAL
Delagoa Bay
Inhaca
Lourenco
Marques
MOZAMBIQUE
Inhambane
Morrumbene
100 metres
500 metres
24
26
28
30
13
32
15
34
17
19
38
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37
24

MAP Southern Africa with inset of larger area including Madagascar, showing the three offshore localities dealt with in Appendices I, II and IV. The even numbers represent latitude S and the odd ones longitude E.

## Class *CRINOIDEA*

## Family COLOBOMETRIDAE

### *Oligometra serripinna occidentalis* A. H. Clark

*Oligometra serripinna* var. *occidentalis* A. H. Clark, 1911 : 33–34 ; 1947 : 239–240, pl. 26, fig. 136, pl. 28, figs. 150–151, pl. 30, fig. 163.

MATERIAL. AFR 1028J, 28°28′S : 32°25′E (off N. Natal), 27 metres ; 3 specimens.

NAD 2W, 30°47·1′S : 30°29·1′E (S of Durban), 44 metres ; 1 specimen.

DESCRIPTION. The largest specimen from sample AFR 1028 has the centrodorsal discoidal with the perfectly flat dorsal pole 2·3 mm in diameter. The cirri are arranged in a single crowded and in some parts staggered ring around the edge. The longest are c. 10 mm long with 22 segments, all shorter than broad.

The division series are narrow, rounded laterally, and the adjacent ones are well separated from one another. The proximal arm syzygies are regularly placed at brachials 3 + 4, 9 + 10 and 14 + 15. The breadth at the first syzygy is 1·1 mm and the length from the proximal edge of the $IBr_1$ to 9 + 10 is 5·5–6·0 mm.

The proximal pinnules are markedly prismatic but not the distal ones. The latter have about 21 segments, most of which are half again to twice as long as broad and they measure 5·5–6·0 mm in length. $P_2$ is much stouter than either $P_1$ or $P_3$ and only tapers beyond the proximal half. The last three or four segments are small.

The arms are patterned with dark stripes, especially at some of the joints. These are maroon in spirit but in life the colour was banded yellow and brown.

Some numerical details of this and two other specimens from Natal are given in Table 1 together with those for two specimens from Cargados Carajos, north of Mauritius, seen earlier in the British Museum collections by A. H. Clark. The large number of cirrus segments in the fourth specimen in the table is noteworthy but smaller specimens from that locality agree in the counts with those from Natal. The relative proportions of the proximal pinnules appear to be fairly consistent but their shape is rather variable. In the smaller specimen from Cargados Carajos included in the table the segments are shorter and much more ornate than usual in this subspecies with flaring distal processes. However, another from the same locality is indistinguishable from those from Natal in having the early pinnules very flat and the last seven or eight segments slightly flared at the sharp outer edge distally, each following segment being narrower so that the profile of the tapering part of the pinnule is serrated without being markedly spinose.

TABLE 1

Numerical data from three specimens of *Oligometra serripinna occidentalis* from Natal and two from Cargados Carajos, in that order

| Arms | | Cirri | | $P_1$ | | $P_2$ | | $P_3$ | |
|---|---|---|---|---|---|---|---|---|---|
| Length | Breadth at 3+4 | No. | Segs. | Segs. | L. | Segs. | L. | Segs. | L. |
| c. 50 | 1·1 | XX | 16–22 | 14 | 4·0 | 16, 17 | 5·5 | 14 | 4·0 |
| 50 | 1·0 | XIX | 17–21 | 15 | 4·2 | 16, 17 | 6·0 | 13 | 3·5 |
| 33 | 0·9 | XVII | 17–19 | 12 | 3·5 | 14 | 5·0 | 12 | 3·5 |
| c. 80 | 1·4 | XIX | 22–29 | 14 | 5·0 | 16 | 7·0 | 14 | 5·0 |
| c. 55 | 1·1 | XVII | 19–21 | 14 | 4·0 | 17 | 6·0 | 14 | 4·0 |

The largest specimen from Cargados Carajos has the dorsal ridges of the middle cirrus segments rising at each end to a slight peak and a similar modification is shown in the smallest Natal specimen tabulated. In the other material examined the ridges appear fairly level, in side view resembling a single small acute tubercle arising at about the middle of the length of the segment or slightly towards the distal end.

REMARKS. It is possible that *Decametra durbanensis*, which I described in 1951 on the basis of a single specimen also from Natal (29°30·8'S : 31°23'E) in 68 metres may prove to be synonymous with *Oligometra serripinna occidentalis*. The holotype is relatively large with an arm length of 90 mm and breadth at 3 + 4 2·0 mm. The cirri are very stout and the dorsal surfaces of the proximal segments are studded with small tubercles, so that they appear very different to the smooth segments of the present material. The centrodorsal is similarly discoidal with marginal cirri, numbering as many as XXVII and with up to 32 segments. However, the segments of the proximal pinnules are no more numerous than those of *O. serripinna occidentalis*, though the proportions of the first three pinnules are similar.

In his key to the genera of Colobometridae (1947 : 9) A. H. Clark distinguished *Decametra* from *Oligometra* in the following terms :

> '$k^1$ The proximal cirrus segments bear dorsally a transverse ridge which distally becomes a pair of tubercles or small spines, or rarely a single median spine ; $P_a$ is absent ; $P_2$ is rounded or rounded prismatic with the distal ends of the segments uniformly spinous or smooth . . . . . . . . *Decametra*
>
> $k^2$ Cirrus segments all with a transverse ridge dorsally except for the penultimate which bears the opposing spine ; $P_a$ present (or rarely absent on some arms) ; $P_2$ more or less strongly prismatic with the distal portion of the prismatic ridges on each segment produced into more or less broad finlike processes, or with the distal ends of the prismatic ridges bearing tufts or spines . . *Oligometra*'

In the holotype of *Decametra durbanensis* $P_a$ is absent on all but two of the arms. In all four specimens of *Oligometra serripinna occidentalis* from Natal $P_a$ is present throughout and the same is true (with the exception of single arms of two specimens) in eight out of the nine from Cargados Carajos. However, in the ninth and largest with the arm breadth 1·4 mm $P_a$ is absent on all the arms and $P_b$ is also missing on two arms one of which even lacks $P_c$ as well. A. H. Clark also noted that the two small specimens from John Murray Expedition st. 45 (South Arabian coast) lack $P_a$ ; one of them has the arms only 25 mm long. *Oligometra serripinna macrobrachius* from the East Indies regularly lacks $P_a$. In the Red Sea *Decametra chadwicki* may have more arms with $P_a$ than without, as I noted in 1967. Clearly this character alone is unreliable as a generic distinction.

With regard to the dorsal armament of the cirrus segments, A. H. Clark included in *Decametra* several species, notably the type species *D. modica*, in which the transverse dorsal ridge of the middle segments never resolves itself into a pair of tubercles on the distal segments. Unfortunately no examples of these species larger than 50 mm arm length have yet been described and it is possible that this character only manifests itself with increasing size.

As for the development of processes or spines on the segments of $P_2$, judging from the descriptions of various specimens of *Oligometra serripinna* in A. H. Clark's monograph, it is very variable and in the subspecies *occidentalis* it is usually very slight.

*Oligometra serripinna* is the type species of *Oligometra*. If further studies of these three characters substantiate their unreliability as being of generic weight, then *Decametra* A. H. Clark, 1911 will be better referred to the synonymy of *Oligometra*, established three years earlier.

RANGE. These records extend the range of *Oligometra serripinna* south-west from Mauritius into South African waters.

## Family **TROPIOMETRIDAE**

### ***Tropiometra magnifica*** A. H. Clark

*Tropiometra magnifica* A. H. Clark, 1937 : 90–91, pl. 1, fig. 1 ; 1947 : 266–268, pl. 33, figs. 170–173 ; A. M. Clark, 1972 : 131–132.

MATERIAL. PED 5W, 24°46′S : 35°18′E (S of Inhambane, Mozambique), 110 metres ; 2 broken specimens.

An error in my paper of 1972 concerning this species (p. 131, bottom line) needs to be corrected. The cirrus length should be 'up to 80 mm' (not 4·0–4·5 mm).

RANGE. This record provides an extension of range southwards from Kenya and the Gulf of Aden.

## Family **THALASSOMETRIDAE**

### ***Crotalometra magnicirra*** (Bell)

*Antedon magnicirra* Bell, 1905c : 141, pl. 4.
*Crotalometra magnicirra* : Gislén, 1938 : 17–18 ; A. H. Clark, 1950 : 97–100.

MATERIAL. This species is only represented in the present collections by a sample of 5 specimens from the South-West Indian Ocean Ridge (see Appendix, p. 482); as it has never been properly described, details are given here of a syntype, B.M. registered number 1904.6.28.16–19 (part), 'Pieter Faure' no. 12885–6, East London, Buffalo River bearing N 15 miles distant, 567 metres.

DESCRIPTION. The arm length is c. 110 mm ; the breadth at $3+4$ is 1·7 mm and the length from the proximal edge of the $IBr_1$ to the syzygy at $3+4$, including a IIBr series of four ossicles, is 11 mm.

The centrodorsal is rounded hemispherical ; 6·5 mm in basal diameter and 4·0 mm across the convex dorsal pole. The cirrus sockets are in ten very definite columns, two in each interradius, with a narrow bare wedge-shaped concave radial area separating the pairs of columns from each other. There are three sockets in each column, though the apicalmost one may be obsolete and the peripheral one may bear only an immature cirrus. The number of mature cirri is therefore best estimated at c. XXV. Of the few remaining mature peripheral cirri, most have c. 63 segments and measure c. 55 mm in length, which is approximately half the arm length. The ninth or tenth is the transition segment and is the longest, measuring c. 2·0 mm by 1·0 mm median breadth. The proximal segments are hardly at all constricted in the middle or flared distally. Beyond the tenth, the segments become relatively shorter so that the seventeenth is as long as broad and the more distal ones are broader than long. The shorter segments are all evenly flared towards their distal ends on the dorsal side and end abruptly, so that the profile of the cirrus is very serrated.

The division series have lateral flanges with straight edges so that adjacent ones are in close apposition. The synarthrial tubercles are very low and rounded, hardly evident at all. There were probably 20 arms (two IIBr series are broken). All the IIBr series are 4 $(3+4)$. The first brachial syzygy is at $3+4$, the second at $17+18$ or beyond. The distal intersyzygial interval is from four to eight muscular joints.

$P_D$ on $IIBr_2$ has 22–27 segments and is c. 12 mm long. $P_1$ has c. 19 segments and is c. 9 mm long. $P_2$ with c. 12 segments is 5 mm long and $P_3$ is similar to $P_2$. The distal pinnules have c. 14 segments and measure c. 6·5 mm. The proximal pinnules are markedly prismatic at the base, with a high dorsal crest which becomes displaced after the first two or three segments towards the inner angle. The segments are short but flared distally and distinctly spinose. The gonads are not at all enlarged. The distal pinnules are markedly prismatic, the segments not more than twice as long as wide and with the side and covering plates distinct.

VARIATIONS. The 15 other syntypes of *Crotalometra magnicirra* are variable with regard to certain characters. The centrodorsal is usually flattened hemispherical but may resemble a truncated high cone with the apex more or less convex, or a complete low cone about two-thirds as high as broad basally. The number of cirri varies according to the size of the centrodorsal. There may be some columns with four sockets but then the apicalmost is usually obsolete or the peripheral cirrus is immature. The maximum number of cirri found is XXXIII but commonly there are c. XXV.

One specimen has only ten arms, the longest remaining being 75 mm long, having lost c. 15 mm. The breadth at $3+4$ is 1·9 mm and the length from $IBr_1$ to $3+4$ is only 5·0–5·5 mm, no IIBr series intervening. Most of the other specimens have 20 arms or at least 15. Only one has a IIBr series of only two ossicles, all the rest are of four. The arm breadth at $3+4$ is usually 1·8–2·0 mm and the length to this syzygy including a IIBr4 series is 11–12 mm.

The longest cirrus found measures c. 60 mm and the greatest number of segments is 64. The few specimens with both a complete arm and a complete mature cirrus show a ratio of just over 2 : 1.

In the ten-armed specimen $P_2$ (equivalent to $P_1$ in the other specimens since no $P_D$ occurs) has 12 segments and measures c. 5 mm ; $P_3$ with 11 or 12 segments is 4·5 mm and $P_4$ with 11 is 4·0 mm.

Two specimens from the same sample as the one described have a syzygy at brachials $1+2$ on some or all arms following a IIBr series, as noted by Gislén (1938). One of them has only eight arms based on IIBr series remaining attached and six of these have a syzygy at $1+2$. In the second specimen all 14 arms of this kind remaining also show such an initial syzygy. Both specimens are rather slender and it may be significant that none of the stouter individuals share this distinction.

Several of the syntypes have an abrupt change to a paler colour at the first brachial syzygy or sometimes at $IIBr3+4$, as if they have regenerated from that point, indicating damage so drastic that survival and recovery is surprising when feeding powers must have been badly impaired for a prolonged period.

Although the majority have the division series and brachials quite smooth, in one specimen there are distinct thorns along the edges of the joints.

REMARKS. This species is sympatric with *Glyptometra sclateri* (Bell), with which it has a number of characters in common. *Glyptometra* belongs to the family Charitometridae and *Crotalometra* to the Thalassometridae but both of these fall within the superfamily Tropiometrida. The two species both have conspicuous side and covering plates along the ambulacra, prismatic distal as well as proximal pinnules, usually more than 10 arms with the IIBr series of four ossicles, well-plated discs and laterally flared division series and proximal brachials. Apart from the very different cirri, the long ones of *Crotalometra* having a distinct transition segment, the present material suggests that *Crotalometra magnicirra* can be distinguished from *G. sclateri* by the normal occurrence of the first brachial syzygy at brachials 3+4 (though 1+2 may occur) and by the smaller pinnules, the genital ones of *Crotalometra* having only a vestige of the lateral expansion so distinct in *Glyptometra*. Also the centrodorsal seems to be relatively higher in most specimens of *C. magnicirra*, the height usually about two-thirds the basal diameter, while the shape may be quite conical in some specimens.

## Family **CHARITOMETRIDAE**

### ***Glyptometra sclateri*** (Bell)

*Antedon sclateri* Bell, 1905c : 140, pl. 3.

*Pachylometra sclateri* (pt.) : H. L. Clark, 1923 : 234 [armless adult only ; non *P. sclateri* (?) : Gislén, 1938 : 18–20, which represents *Gislenometra perplexa* A. H. Clark, 1947, like H. L. Clark's small specimens.]

*Glyptometra sclateri* : A. H. Clark, 1950 : 268–270.

MATERIAL. Again this species is only represented in the present collections by material from the South-West Indian Ocean Ridge (see Appendix, p. 482) but since it has never been fully described details are given here of a syntype, British Museum registered number 1904.7.3.6–10 (part), 'Pieter Faure' no. 12711, East London bearing NW ½ N distant 18 miles, 457–549 metres.

DESCRIPTION. The arms are all broken but were probably at least 80 mm long ; the breadth at 3+4 is 2·0 mm and the length from the proximal edge of the $IBr_1$ to the syzygy at 3+4, including a IIBr series of four ossicles, is 9·0 mm.

The centrodorsal is flattened hemispherical, the rugose dorsal pole 3·5 mm in diameter, the peripheral diameter 6·0 mm and the height 2·3 mm. Some of the cirrus sockets seem to be arranged in columns but others are crowded out of alignment.

The cirri number c. XXXV and have up to 18 segments, their length being at the most 22 mm. The longest segments are the sixth to the eighth, the sixth on one cirrus measuring 1·8 mm in median length and 1·1 mm median breadth. The following segments are relatively shorter, except for the penultimate, which is abruptly narrower than the antepenultimate ; its opposing spine is terminal and directed distally, as is usual in the family Charitometridae. The antepenultimate and preceding short segments are all slightly flared at their distal ends, the more proximal ones especially on the ventral side, the distal ones on the dorsal side.

The division series have lateral flanges with straight sides so that the adjacent ones are closely apposed. The synarthrial tubercles are low and barely appreciable.

There are 21 arms. All the IIBr series are 4 (3+4) and the only IIIBr series is 2 (1+2). The proximal syzygies are rather irregular in position ; on 12 arms the first is at 1+2 with the following joint a muscular one, on eight arms there are syzygies at both 1+2 and 3+4, while the last arm has a syzygy at 2+3. The brachials of the outer half of the arm are triangular, approximately as long as wide. The intersyzygial interval is usually five, sometimes six, muscular articulations.

$P_D$ on $IIBr_2$ has 28–30 segments and is c. 10 mm long. It is curled inwards over the disc and has short, squarish segments. $P_1$ has c. 27 segments and is 9·5–10·0 mm long, rather similar to $P_D$. $P_2$ has 19 or 20 segments and length c. 8 mm. It is deeper than $P_D$ and $P_1$ at the base but tapers more. The segments after the first six or seven are longer than broad but none are as much as twice as long as broad. $P_3$ is the first genital pinnule ; it has c. 15 segments and is 5·5–6·0 mm long. The first three segments taper like those of $P_2$ but the fourth expands markedly and the fifth and sixth are conspicuously wide, the seventh tapers abruptly and the following segments are much longer, the distal ones twice as long as broad. $P_4$ and the other genital pinnules have a similar expansion of a few of the proximal segments after an initial tapering.

The disc is densely studded with small granuliform plates.

VARIATIONS. Of the 13 other specimens in the British Museum collection – 12 syntypes and one from among the syntypes of *Crotalometra magnicirra* – the arm number is as follows : 10, 11, 11, 13, 14, 15, 17, 17, 17, 18, 19, 20 and 20. In the ten-armed specimen, the arms are 90 mm long. The smallest specimen is an eleven-armed one with an arm length of c. 80 mm and breadth at 3+4 of 1·8 mm. Most of the specimens have all the IIBr series of four ossicles but one has two out of seven IIBr series of two ossicles and another has one out of ten similarly abbreviated. The synarthrial tubercles may be much more prominent than in the specimen described.

The occurrence of proximal arm syzygies is very variable ; a few specimens have the first syzygy at 3+4 on some arms arising from IIBr series, rather than the usual 1+2, as well as on the arms arising from IBr series. One specimen with 19 arms is unusual in having six with 2+3, though nine others have 1+2, three have both 1+2 and 3+4 and one (the only arm arising from a IBr series) has 3+4 alone. Another specimen with 20 arms has none with 2+3, but 16 with 1+2, three with 1+2 and 3+4 and one with 3+4 alone.

The centrodorsal varies in shape from thick discoidal to flattened hemispherical but is never as conical as in some specimens of *Crotalometra magnicirra* ; the dorsal pole ranges from as little as 2·0 mm in diameter to as much as 5·0 mm. There are usually ten cirri around the dorsal pole and in some specimens, particularly the smaller ones, the other cirri may be arranged in quite regular columns in line with the adapical ones. However, in larger individuals there are usually more than ten peripheral cirri and the sockets become crowded irregularly in the interradii, though sometimes they leave bare a space in each radius, which may be wedge-shaped and concave as in *C. magnicirra*. One specimen with a particularly regular columnar arrangement of the cirrus sockets and well-marked radial spaces has all its cirri broken off short and can only be distinguished from *C. magnicirra* by the irregularity of the proximal arm syzygies and the larger pinnules with some expanded segments on the genital ones.

The proximal pinnules vary to some extent. One has $P_D$ with 23 segments, $P_1$ with 19, $P_2$ with 16 and $P_3$ with 13 ; while another has $P_2$ on an arm arising from a IBr series with 22 segments and length 9·5 mm. The ten-armed specimen has $P_1$ with 22 segments but only 6·5 mm long.

## Class *STELLEROIDEA*

## Subclass *ASTEROIDEA*

## Family **LUIDIIDAE**

### ***Luidia*** sp. cf. ***L. avicularia*** Fisher

See : Fisher, 1919 : 172–175, pl. 43, fig. 1, pl. 44, fig. 2, pl. 46, fig. 2.

MATERIAL. SCD 74R, 32°33′S : 28°38′E (off Bashee River mouth, N of East London), 55 metres ; 1 specimen.

Unfortunately this nine-armed *Luidia* has had all its arms broken (or bitten) off short and regeneration is only partial. The large bivalved pedicellaria on the oral face of each jaw plate and the similar but sometimes smaller one on the proximal abradial ends of most adambulacral plates, distinguish it from the similarly nine-armed *L. maculata* Müller & Troschel, which has been recorded from Natal by Mortensen, 1933, the latter having three-bladed pedicellariae on the multiple rather than single actinal plates. The present specimen also differs in having an enlarged spinelet or spine on most of the lateral abactinal paxillae, as in *L. avicularia*, known from the Philippines and Banda Sea, which also agrees in the form of the pedicellariae. Further specimens are needed to settle the specific identification.

## Family **ASTROPECTINIDAE**

### ***Astropecten granulatus natalensis*** John

Pl. 1, fig. 1

*Astropecten granulatus* : H. L. Clark, 1923 : 250–251.
*Astropecten granulatus natalensis* John, 1948 : 5, pl. 1, figs. 1, 2.

MATERIAL. SCD 74Q, 32°33′S : 28°38′E (off Bashee River), 55 metres ; 1 specimen.
NAD 8R, 29°53·6′S : 31°04·6′E (off Durban), 38 metres ; 3 specimens.
NAD 12D, 29° 46′S : 31°17′E, 110–130 metres ; 1 specimen.
NAD 26B, 29°53·5′S : 31°06·1′E, 71 metres ; 2 specimens.
NAD 52A, 29°29′S : 31°45′E, 86 metres ; 5 specimens ['Anton Bruun' st. 391C].

DESCRIPTION. The specimen from East London is much larger than the others so far recorded from South Africa, in which R was less than 40 mm ; it has R 72–74 mm ; r is 16 mm and br (at the fourth superomarginals) also 16 mm ; the paxillar breadth in the same position is 11 mm.

There are 34 superomarginals in a complete series, all lacking spines. The inferomarginal plates each bear two large almost equal spines at the upper end, aligned slightly obliquely, with a third fairly large spine proximal to them usually present as well as a smaller fourth spine below but distal ; on the ventral face are several more spaced spines along the distal side, each longer than the plate, giving a fairly shaggy appearance.

The paxillae are arranged in transverse rows each side of the mid-radius, though a few are slightly irregular; 23 or 24 paxillae correspond to the first ten superomarginals. The larger proximal paxillae have c. 10 central spinelets and 15–20 peripheral ones but some are larger still.

TABLE 2

Numerical data from six specimens of *Astropecten granulatus natalensis* from near Durban

| R | r | Br at SM4 | Paxillar Br | No. of superomarginals |
|---|---|---|---|---|
| 43 | 11·0 | 9·5 | 5·5 | 21 |
| 38 | 11·0 | 9·5 | 6·5 | 19 |
| 35 | 9·5 | 8·5 | 5·5 | 18 |
| 30 | 7·5 | 7·0 | 4·0 | 18 |
| 27 | 8·0 | 6·0 | 4·0 | 16 (17) |
| 20 | 5·5 | 5·0 | 2·5 | 16 |

There are only two actinal plates in each series. The first ten inferomarginals correspond to 16 adambulacral plates.

AFFINITIES. The six specimens from the vicinity of Durban included in Table 2 are the least badly damaged ones. They also have only two actinal plates in each series, like John's material In this they differ from the holotype of *Astropecten anacanthus* H. L. Clark, 1926, also taken in the vicinity of Durban, which has three actinal plates. H. L. Clark otherwise distinguished *A. anacanthus* as having relatively narrower paxillar areas (and consequently more conspicuous superomarginals) and 'totally different' ventral spinulation. The holotype of *A. anacanthus* has R/r 44/11 mm, br is given as 12 mm with paxillar br at the same level 8 mm. Judging from H. L. Clark's rather poor photograph (1926, pl. 1, fig. 1), his br measurement must have been taken proximal to the first superomarginal, i.e. between two adjacent interradial edges. Since the arms flare out at the base, I think that a better estimate of their breadth in *Astropecten* species is given by measuring at the level of the fourth superomarginals, or the fifth as Döderlein does. In the specimen with R 43 mm in Table 2, br between two interradii is 12·5 mm and the paxillar breadth here is 8 mm. The superomarginals appear more conspicuous than those of the holotype of *A. anacanthus*, not less. Nor can I detect any significant difference in the armament of the inferomarginals, which John pointed out is very variable. All the specimens of *A. granulatus natalensis* have at least some of the proximal paxillae with the peripheral spinelets distinctly higher than the central ones, which H. L. Clark did not observe in *A. anacanthus*. Possibly this, together with the difference in the number of actinal plates, may provide a valid distinction; also the relative number of marginal plates in each series may be significant. There are 27 in the holotype of *A. anacanthus* at R 44 mm, compared with only 21 in the first specimen of *natalensis* in Table 2.

The relative number of superomarginals was also used by John to distinguish between *Astropecten granulatus* from Australia and *natalensis* from South Africa;

the large specimen from East London reinforces this, having 34 superomarginals at R c. 74 mm, compared with 40 in an Australian specimen with R 77 mm. The smaller specimens also support this difference. The East London specimen is also notable for having two almost equal large inferomarginal spines on the proximal plates. John has already noted that smaller specimens from Natal have a second inferomarginal spine distinctly larger than in Australian specimens of *A. granulatus*.

LECTOTYPE DESIGNATION. John did not designate a holotype for the subspecies *natalensis* and it is clearly undesirable that the aberrant specimen (no. 29) with a large spine on each of the first superomarginals, of which he illustrated the upper side (1948, pl. 1, fig. 1) be treated as lectotype, while the other specimen he depicted (his pl. 1, fig. 2) is much smaller (R 22 mm) and shown in ventral view. I therefore designate the specimen with R/r 37/11 mm, reg. no. 1904.4.20.120–122 (part), ref. no. 10723 as lectotype. Some numerical data from it are included in John's tables and a photograph of it is now given (Pl. 1, fig. 1).

## ***Astropecten polyacanthus phragmorus*** Fisher

Pl. 1, fig. 2 ; Pl. 2, fig. 1

*Astropecten acanthifer phragmorus* Fisher, 1913 : 604.
*Astropecten phragmorus* : Döderlein, 1917 : 178 ; Fisher, 1919 : 65–67, pl. 11, fig. 5, pl. 14, fig. 1 ; Mortensen, 1940 : 61 ; Clark & Rowe, 1971 : 44.
*Astropecten polyacanthus* : H. L. Clark, 1923 : 249.

MATERIAL. PED 12A, 24°46′S : 34°50′E (Mozambique, between Delagoa Bay and Inhambane), 22 metres ; 3 specimens ['Anton Bruun' st. 372C].

TAXONOMIC RANK. As noted in 1971, Mortensen (1940) has queried the specific validity of *Astropecten phragmorus*, having found many specimens intermediate between it and *A. polyacanthus* in the Persian Gulf, an experience which I have shared in dealing with material from that area. Apart from the three specimens from southern Mozambique, there is an older one in the British Museum collections, ref. no. 49 (details unknown) sent by the Cape of Good Hope Government. (This is not to be confused with the specimen of the same number illustrated as *Astropecten granulatus natalensis* by John.) All four have the complete series of superomarginal spines characteristic of *A. phragmorus*, most of the spines less conspicuous in size than the comparable ones of *A. polyacanthus*, in which the second plate (sometimes also the third) is reduced and spineless, exaggerating the prominence of the pair of spines on the first superomarginals of each series in each interradius (Pl. 2, fig. 2). H. L. Clark (1923) also noticed that the specimen from Natal which he referred to *A. polyacanthus* had smaller superomarginal spines than usual and, although he did not say that the spine series was complete, he did suggest that South African specimens might be subspecifically distinct from *A. polyacanthus*. I agree with this ranking and accordingly now reduce *A. phragmorus* to the status of a subspecies of *A. polyacanthus*.

It may be noted here that in some specimens of *Astropecten polyacanthus phragmorus* the superomarginal plates are less high than is usual in *A. polyacanthus*

*polyacanthus*, as shown by a comparison of figs. 1 and 2 in Plate 2. However, the apparent discrepancy in the number of plates is an illusion caused by the different magnifications ; in fact, the two specimens photographed have a comparable number of marginal plates relative to R.

RANGE. The range of *Astropecten polyacanthus phragmorus* is therefore extended to south-east Africa ; it is otherwise known from the Philippines (the type-locality) and the Persian Gulf.

### ***Dipsacaster sladeni capensis*** A. M. Clark

*Leptoptychaster kerguelensis* : Bell, 1905a : 242–243. [Non *L. kerguelensis* Smith, 1879.]
*Dipsacaster sladeni* : H. L. Clark, 1923 : 246–247 ; Mortensen, 1933a : 237.
*Dipsacaster sladeni capensis* A. M. Clark, 1952 : 204, pl. 17.

MATERIAL. SCD 203C, 34°51′S : 23°41′E (SE of Knysna), 184 metres ; 1 specimen.

R/r is 87/33 mm = 2·6/1 and there are 35 superomarginals in each series, agreeing with the relative number found in previous South African specimens and significantly higher than in *D. sladeni* Alcock from the Bay of Bengal.

### ***Psilaster acuminatus*** Sladen

*Psilaster acuminatus* Sladen, 1889 : 225–228, pl. 40, figs. 1, 2, pl. 42, figs. 7, 8 ; H. L. Clark, 1923 : 248–249 ; Mortensen, 1933a : 236–237.

MATERIAL. AFR 777B, 29°18′S : 15°35′E (SW from Port Nolloth), 384 metres ; 1 specimen.

TRA 73F, 32°06′S : 16°37′E (W from Lambert's Bay), c. 310 metres ; 1 specimen.
TRA 129J, 32°26′S : 16°38′E, 480 metres ; 1 specimen.
AFR 831A, 35°15·3′S : 18°39·3′E (S from False Bay), 547 metres ; 1 specimen.

REMARKS. The northernmost specimen (AFR 777) shows some minor differences from the others. Its madreporite is larger, diameter 1·1 mm, its centre nearer the interradial edge, 3·0 mm, R/r being 30/8·5 mm in comparison with specimen TRA 73, in which the same measurements are 0·75 mm, 3·4 mm and 29/8·5 mm. Its armament of furrow and marginal spines and granules is consistently more attenuated and it even has a slightly elongated granule at the distal edge of some superomarginals about one-third the height from the upper end of the plate, forming an incipient superomarginal spine. Its adambulacral plates have more pronouncedly angular furrow margins. As preserved, it has no anal cone, unlike the other specimens.

In comparison with *Bathybiaster vexillifer*, this species has relatively fewer superomarginals and these do have a small horizontal face rather than being restricted to the lateral face of the arms. . *B. vexillifer* (at least the holotype of *Phoxaster pumilus* (Sladen), which is believed to be synonymous) has 40 marginals at R c. 40 mm, in comparison with 30 at R 30 mm in one of the present specimens of *Psilaster acuminatus*.

## Family GONIASTERIDAE

### *Ceramaster patagonicus euryplax* H. L. Clark

*Ceramaster patagonicus* var. *euryplax* H. L. Clark, 1923 : 262–264, pl. 14, figs. 1, 2 ; 1926 : 11 ; A. M. Clark, 1952 : 204–205.

*Ceramaster chondriscus* H. L. Clark, 1923 : 258–260, pl. 14, figs. 5, 6 ; Mortensen, 1933a : 242–243.

MATERIAL. AFR 729C, 31°22·8′S : 16°20·2′E (W from Hondeklip Bay), 365 metres ; 3 specimens.

TRA 7C, 48 miles W by S of Cape Town, c. 34°S : 17°E, 402 metres ; 1 specimen.

REMARKS. R/r is 35/21 mm = 1·67/1, 50/30 mm = 1·67/1, 51/29 mm = 1·76/1 and 60/32 mm = 1·88/1. The number of superomarginals in each series is respectively 12, 15 (or 16), 14 and 19. The smallest specimen has most of the upper surface of all the superomarginals bare but the larger ones have only small bare patches on the distal plates.

The superomarginals are squarish in shape, the paxillar spinelets are angular and the distal subambulacral spines are hardly at all enlarged, so these specimens run down to *Ceramaster chondriscus* in H. L. Clark's key (1923). Mortensen and I have already pointed out the lack of distinction between *C. chondriscus* and *C. patagonicus euryplax* and I believe that they are synonymous. In fact, the former has page priority in H. L. Clark, 1923 but, since I regard the difference between South African and Patagonian specimens as less than a specific one, it seems better to retain the existing trinomial than to introduce the combination *C. patagonicus chondriscus*. Since there is a geographical distinction, the rank is that of a subspecies rather than a variety.

## Family OREASTERIDAE

### Genus *ASTERODISCIDES* nom. nov.

*Asterodiscus* Gray, 1847 : 75 [Non *Asterodiscus* Ehrenberg, 1839, Protozoa.] Type-species : *Asterodiscus elegans* Gray, 1847.

I am obliged to Dr D. L. Pawson and Miss M. Downey for notification of the homonymy of this generic name.

### *Asterodiscides elegans* Gray

*Asterodiscus elegans* Gray, 1847 : 75 ; Macnae & Kalk, 1969 : 129 ; Clark & Rowe, 1971 : 34, 40.

MATERIAL. NAD 20M, 29°58′S : 31°02′E (off Durban), 49 metres ; 1 specimen.

RANGE. This record provides a small extension of range from Inhaca.

## Family OPHIDIASTERIDAE

### *Hacelia capensis* Mortensen

*Hacelia superba* var. *capensis* Mortensen, 1925 : 152.

MATERIAL. NAD 91F, 29°11′S : 32°02′E (SE of Richard's Bay, Natal), 70 metres; 1 specimen ['Anton Bruun' st. 357B].

DESCRIPTION. Unfortunately this specimen (only the second to be taken) is small with R/r only 15/3 mm = 5/1; br basally is 3 mm and at half R also 3 mm since the arms only taper in their distal half.

There are nine complete longitudinal series of plates on each arm (not counting the adambulacrals), one dorso-lateral series each side of the carinal row, two marginals and one actinal each side, with eight series of papulae between them. The granulation is slightly coarser on the middles of the plates. There is also a partial second series of actinal plates proximally, above the main series, consisting of two rounded plates on the disc and very base of the arm and about six other very narrow plates corresponding in position and very close to the inferomarginals. There are 16 (or 17) superomarginals in each series, the last seven to ten with a large bare central area, as also on most of the carinal plates except for the first two to four. The terminal plates are very large and convex. The papulae are relatively few, only one or two in each area, those below the inferomarginals single. The subambulacral spines are up to twice as long as broad; the two furrow spines of each plate are slightly spaced from those of adjacent plates; there are no granules on the furrow faces of the plates. Pedicellariae are numerous, tong-shaped, their valves very compressed beyond the base and not at all expanded sideways terminally. Their sockets have prominent flanged edges. There is usually a pedicellaria in each papular area above about five consecutive superomarginals at about one-third the arm length and several others in other papular areas on the upper side but not below.

NOMENCLATURE. *Hacelia superba* H. L. Clark, 1921 from off Barbados in the West Indies was referred by A. H. Clark (1948) to the synonymy of *H. floridae* (Perrier, 1881), which species Downey (1971) has referred back to *Tamaria* without reference to *H. superba* in her synonymy. The holotype of *H. superba* was the largest specimen, R 75–78 mm, and had actinal papular areas below the inferomarginal plates with up to eight papulae in each; accordingly it could not be referred to *Tamaria* in which the absence of proper actinal papular areas is diagnostic. In *H. floridae* (and *H. superba* if distinct) the arms taper evenly from the base in contrast to this South African specimen and also differ in having pedicellariae on the under side, not above, and small terminal plates. Also only the holotype of *H. superba* had any distal marginal plates medially bare; judging from the descriptions of Verrill (1915, as *Ophidiaster alexandri*) and Downey all small specimens are fully granulated.

In spite of its small size, I am sure that this South African specimen is not conspecific with the West Indian species, whether or not that is a *Hacelia*. Also it looks more like an *Ophidiaster* superficially, with which the eight series of papulae agree but of course the fact that there are not ten series, as in *Hacelia*, could well be due to the small size. Mortensen did not even give the size of his specimen – the holotype – and only distinguishes it from *H. superba* by the more numerous centrally bare plates including dorso-lateral as well as carinal plates. Pending discovery of larger South African specimens, it seems best to retain the combination of *capensis* with *Hacelia*.

## Family **ASTERINIDAE**

### *Asterina gracilispina* H. L. Clark

*Asterina gracilispina* H. L. Clark, 1923 : 286–287, pl. 16, figs. 3, 4 ; Mortensen, 1933a : 255–256.

Material. FAL 720D, 34°07′S : 18°45′E (False Bay), 20–26 metres ; 1 specimen.
CP 710A, no data ; 1 specimen.
AG 2E, Cape Agulhas (nearly 35°S : 20°E) ; 1 specimen.
MB 13C, 34°04′17″S : 22°13′53″E (Mossel Bay) ; 1 specimen.
SCD 155U, 34°03′S : 25°59′E (Algoa Bay), 85 metres ; 1 specimen.
SCD 177K, 34°20′S : 23°31′E (SE of Knysna), 56 metres ; 1 specimen.

Unfortunately most of these specimens are in poor condition ; the two from Mossel Bay and Cape Agulhas are the best. They have R/r respectively 6/4·5 mm = 1·3/1 and 12/9 mm = 1·3/1. The holotype was dried and this probably accounts for the choice of specific name which conflicts with Mortensen's comment that his wet specimen has the abactinal spinelets blunt, not 'short, sharp' as in the type. The present wet specimens agree in general with Mortensen's but their abactinal spinelets extend all over the plates, not leaving a bare central patch and average about 12 per plate in the smaller and c. 15 in the larger. Other spine counts include : actinal spines 3–5 (in a straight row) and 2 or 3 ; subambulacral spines 3 and 3 to 2 ; furrow spines 4 to 3 and 4 or 5 ; suboral spines 2 and 3 sometimes 4 ; oral furrow spines 6 and 9. The madreporite is only visible in the larger one. This is also true of the specimen from south of Algoa Bay, where R/r is 10/7·5 mm = 1·3/1 and the actinal spines number 3–5 on each plate.

CP 710A is rather flattened, the arms distinctly petaloid ; R/r is 18/12 mm = 1·5. It retains some purple colour on the upper side except peripherally and small patches near the centre which are buff-yellowish ; there are 2–4 actinal spines, usually 3 ; 4 furrow spines ; 2 or sometimes 3 subambulacral and 3 suboral.

### *Asterina burtoni* Gray

*Asterina burtonii* Gray, 1840 : 289 ; H. L. Clark, 1923 : 283 ; Smith, 1927 : 641–645.
*Asterina burtoni* : A. M. Clark & Rowe, 1971 : 68–70, pl. 9, figs. 4, 5.

Material. PEA 2P, Maxixe, Mozambique (c. 25°S : 32°E), LW ; 7 specimens.
JAN 26G, Jangamo reef, Mozambique (c. 24°S : 35°E) ; 1 specimen.
MOR 6F, Morrumbene, Mozambique (c. 23°S : 35°E) ; 1 specimen.

One of the first sample has six arms and three madreporites ; the rest have five and one, as usual in East African specimens.

The specimen from Jangamo reef has unusually long arms, R/r 25/9 mm = 2·8/1. From above it closely resembles the larger of the two specimens from Zanzibar which I called *Paranepanthia* sp. in 1971 ; that has R/r 30/11 mm = 2·7/1. Both have a distinct boundary between the mid-radial and lateral 'fields' of abactinal plates, though in the Jangamo specimen the innermost plates of the lateral series are not noticeably larger than the second row of plates, unlike the Zanzibar specimen. However, from the under-side there is a marked difference from *Paranepanthia* in the armament of the actinal plates, which consists in JAN 26 of fans of three to five spines, similar to the subambulacral spines, as usual in *Asterina burtoni*, but of clusters of 7–12 on most plates of the Zanzibar specimen.

### ***Patiriella dyscrita*** (H. L. Clark) new comb.

*Asterina dyscrita* H. L. Clark, 1923 : 284–285, pl. 16, figs. 5, 6.
*Asterina* (*Patiriella*) *exigua* (part) : Mortensen, 1933a : 252–255.

MATERIAL. BRE 78F, c. 33°S : 19°E (Breede River estuary) ; 3 specimens.
E 3B, c. 33°S : 25°E (Port Elizabeth), below LWS ; 1 specimen.

NOMENCLATURE. Dartnall (1971) has reviewed *Patiriella exigua* and recognizes two species from South African waters, one (the true *P. exigua*) with downwardly directed gonopores and the other with upwardly directed ones. As quoted in Dartnall's paper, I think that the latter is conspecific with H. L. Clark's *Asterina dyscrita*. Since Dartnall has split off a tropical Indo-West Pacific species that also has dorsal gonopores as *Patiriella pseudoexigua*, clearly he does not consider the different alignment of these pores warrants a generic distinction. As *A. dyscrita* is otherwise so similar morphologically to *P. exigua*, I propose to refer it to *Patiriella*. Preserved colourless specimens where the position of the genital openings is often difficult to detect are all likely to be referred to *P. exigua*, though in life the greenish-blue of its lower side will distinguish that species from *P. dyscrita*.

## Family **SOLASTERIDAE**

### ***Lophaster quadrispinus*** H. L. Clark

*Lophaster quadrispinus* H. L. Clark, 1923 : 295–297, pl. 18, figs. 1, 2 ; 1926 : 21 ; Mortensen, 1933 : 272.

MATERIAL. AFR 730A, 31°29′S : 16°03′E (W of Lambert's Bay), 459 metres ; 1 specimen.
TRA 8A, 42 miles W by N of Cape Town (c. 33°S : 17°E) ; 1 specimen.
WCD 214A, 34°29′S : 18°16′E (W of Cape Point), 400 metres ; 1 specimen.

Whereas H. L. Clark gives the number of furrow spines on each plate in the proximal half of the arm of the holotype (R 70 mm) as four and Mortensen (size not given) as five to six, no. AFR 730A with R 60 mm has only three furrow spines on most plates, only a few proximal ones with four and at least one with only two. The same is true of the dry specimen, TRA 8A, R again c. 60 mm, in which only about two proximal plates of each series have four spines, the rest three.

## Family **ECHINASTERIDAE**

### ***Henricia reticulata*** (H. L. Clark) new comb.

*Echinaster reticulatus* H. L. Clark, 1923 : 290–292, pl. 15, figs. 1, 2 ; Mortensen, 1933a : 264–265.

NOMENCLATURE. Fisher (1940 : 272) has pointed out Mortensen's inconsistency in referring *Henricia ornata* (Perrier) back to *Echinaster* on the grounds that it has no actinal papulae but leaving *E. reticulatus*, with such papulae, still in *Echinaster*.

Unfortunately, however, Fisher's own attempt to distinguish between *Echinaster* and *Henricia* on the supposed longitudinal webbing of the innermost subambulacral spines in *Echinaster* is not reliable. Although some specimens of the type-species, *E. sepositus* (Lamarck) [perhaps properly called *E. sentus* (Retzius)], are preserved with the skin-covering appearing markedly thickened and giving some effect of longitudinal webbing, the usual condition is for the spine sheaths to be independent, with a distinct crease between adjacent plates.

In the armament of the abactinal plates, *H. ornata* does span both genera, specimens with coarser, spaced spinelets resembling *Echinaster*, whereas others in which there are linear or even doubled series of spinelets along the reticulations of the skeleton agree with *Henricia*. This is a notoriously difficult family to classify.

## Family **ASTERIIDAE**

### ***Marthasterias glacialis*** forma ***africana*** (Müller & Troschel)

*Asteracanthion africanus* Müller & Troschel, 1842 : 15.
*Asterias africana* : Döderlein, 1910 : 252.
*Marthasterias africana* : H. L. Clark, 1923 : 306.
*Marthasterias glacialis* var. *africana* : Mortensen, 1933a : 273–274, pl. 16, fig. 1.

MATERIAL. FBY 133J, False Bay, no details ; 1 specimen.

R/r is c. 110/c. 20 mm = 5·5/1, maximum br c. 30 mm but possibly less in life since the arms have flattened in preservation somewhat. Even allowing for this, the arms are unusually short and fat. It is also unusual in having about ten proximal actinal plates each with a spine, simulating a third inferomarginal spine as they are in series. The pedicellaria wreaths on the outer inferomarginal spines wrap well round and appear to be more or less fused to some of the inner spines as well. However, some northern specimens of *M. glacialis* also show this. There are not very many dorso-lateral spines but the carinal plates have up to four spines on a single plate. The more lateral parts of the dorso-lateral areas are fairly bare but not so obviously so as in the forma *rarispina*. The largest straight pedicellariae have broad rounded tips, sometimes with digits, unlike Fisher's description for northern *M. glacialis* (1928) as 'slender lanceolate to ovate'.

### ***Perissasterias polyacantha*** H. L. Clark

*Perissasterias polyacantha* H. L. Clark, 1923 : 307–309, pl. 18, fig. 3 ; 1926 : 29–30, pl. 6 ; Mortensen, 1933a : 278.

MATERIAL. AFR 736N, 30°42·4′S : 15°59·2′E (SW of Hondeklip Bay), 201 metres ; 1 specimen.

This specimen is dried ; it has R only c. 100 mm, whereas H. L. Clark's material had R 260 to over 300 mm. This probably accounts for it having only three adambulacral spines, when he described five to seven. The carinal spines are tapering and bluntly pointed, unlike *Perissasterias obtusispina* H. L. Clark, 1926, the only specimen of which (R c. 160 mm) has low capitate spines. The latter has four adambulacral spines on most plates and I think will prove to be conspecific with *P. polyacantha* when more material is available ; the shapes of abactinal spines are often very variable in this family.

## Subclass *OPHIUROIDEA*

### Family **GORGONOCEPHALIDAE**

### ***Astrocladus euryale*** (Retzius)

Pl. 3, figs 1 and 2

*Asterias euryale* Retzius, 1783 : 243.
*Euryale verrucosum* Lamarck, 1816 : 537.
*Gorgonocephalus verrucosus* : Lyman, 1882 : 262–263 ; Bell, 1905b : 260.
*Astrocladus verrucosus* : Döderlein, 1910 : 256.
*Astrocladus euryale* : Döderlein, 1911 : 28, 40, 106 ; H. L. Clark, 1923 : 319 ; Mortensen, 1933a : 293–296, figs. 21, 22, pl. 18, fig. 7.

MATERIAL. AFR 842C, 34°34′S : 19°18′E (W of Cape Agulhas), 31 metres ; 1 specimen.

SCD 32U, 33°38·6′S : 26°54·7′E (W of Port Elizabeth), 55 metres ; 1 large and 2 small specimens.

SCD 42K, 32°15·2′S : 28°57·7′E (off Bashee River), 47 metres ; 1 small specimen.

SCD 57W, 33°37′S : 26°56·6′E (W of Port Elizabeth), 46 metres ; 5 specimens.

SCD 91C, 33°03′S : 27°55′E (S of East London), 27 metres ; 4 specimens.

SCD 155P, 34°03′S : 25°59′E (S of Port Elizabeth), 85 metres ; 2 specimens.

SCD 355A, 34°03·3′S : 25°43·5′E, 38 metres ; 1 specimen.

VARIATIONS. In his key to the family Gorgonocephalidae, Döderlein (1911 : 28) used the presence or absence of tentacle scales (or arm spines) before the first fork in the arms as one of the main dichotomies, *Astrocladus* being included among the genera in which these are absent (at least in adult specimens). However, of the specimens now referred to *Astrocladus euryale*, only the one from west of Cape Agulhas (AFR 842C) does not have spines before the first fork. It has disc diameter (d.d.) 60 mm. All the others come from east of Cape Agulhas and have spines developed before the first fork to some degree. Apart from this, I cannot discern any significant difference between them to warrant a specific, let alone a generic distinction. Of the 'Challenger' specimens from False Bay, the largest (d.d. 75 mm) has two very short spines adjacent to several pores before the first fork, including those of the third arm segment, just projecting from the granulation, though consecutive segments all have spines only after the first fork. A smaller specimen from the same station (d.d. 40–44 mm) has short spines, at first two then three, starting at the second segment but another with d.d. 47 mm shows no spines at all before the first fork. The largest of sample SCD 91C (d.d. 45 mm), as well as the smaller ones, has three spines at the second tentacle pores increasing to four, though the largest from SCD 57W of similar size (d.d. 40–45 mm) only has two very short spines on these early segments. Clearly there is much more variation in the degree of reduction of these spines with growth than has hitherto been allowed for. Mortensen (1933) thought them suppressed from about d.d. 20 mm, while H. L. Clark (1923) gave the critical size as 15 mm. The holotype of Mortensen's *Astroconus capensis* has d.d. 30 mm and superficially resembles *Astrocladus euryale* in the tubercles on the radial ribs. It has two arm spines by the second and following pores before the first arm fork, which presumably prompted its inclusion in *Astroconus* rather than *Astrocladus*. It also lacks the belts of hook-bearing platelets which Mortensen discovered on the distal arm segments of *Astrocladus euryale*. These platelets are found at least in the largest specimen from SCD 91C (d.d. 45 mm) (and from the third fork onwards, not just distally) but, as noted above, this specimen also has arm spines before the first fork.

It seems to me that a reappraisal of the taxonomic characters in use for the family Gorgonocephalidae in the light of ontogenetic changes and variation is badly needed. It is possible that some use can be made of the average number of segments between successive forks on the arms but this distinction may also prove to be untenable. It may be noted that most of the specimens now referred to *Astrocladus euryale* have only six to eight, sometimes nine, segments between most of the forks on the main branches, whereas the holotype of *Astroconus capensis* has 12–13 on the main branches and seven or eight only on the side branches. The type-locality of Mortensen's species was off Natal (c. 30°S : 31½°E). Most of the specimens he referred to *Astrocladus euryale* were from False Bay and Walker Bay (west of Cape Agulhas) and were large with d.d. 50–60 mm but he also referred specimens from East London (size not given) to the same species.

## Family **OPHIACANTHIDAE**

### ***Ophiomitrella corynephora*** H. L. Clark

*Ophiomitrella corynephora* H. L. Clark, 1923 : 322–324, fig. 2, pl. 19, figs. 5, 6 ; Mortensen, 1933a : 331–333, figs. 48, 49.

MATERIAL. AFR 743F, 30°S : 15°E (W of Hondeklip Bay), 102 metres ; 4 specimens.

WCD 25U, 33°06·5′S : 17°55·5′E (near Saldanha Bay), 79 metres ; 17 specimens.
WCD 219C, 34°42·8′S : 18°08·8′E (SW of Cape Point), 360 metres ; 6 specimens.
SCD 4A, 34°30′S : 24°40′E (SW of Cape St Francis), 102 metres ; 2 specimens.
SCD 177C, 34°20′S : 23°31′E (SE of Knysna), 56 metres ; 7 specimens.
SCD 249E, 34°48′S : 23°39′E (SE of Knysna), 146 metres ; 4 specimens.
SCD 320F, 34°15′S : 25°50·5′E (S of Port Elizabeth), 108 metres ; 1 specimen.

Contrary to H. L. Clark's figure, not all specimens of *Ophiomitrella corynephora* have the radial shields completely separated. In several smaller ones the radial shields of some pairs at least are just contiguous, for instance in one from SCD 4A with d.d. 3·5 mm, which also has relatively large radial shields, 0·75 mm long or nearly half the disc radius.

One of the seven from SCD 177C has unusually short disc stumps and arm spines. Unfortunately the ventral side is concealed since it is wrapped around a gorgonian.

### ***Ophiacantha*** sp. juv., aff. ***O. striolata*** Mortensen

Material. WCD 140K, 34°16′S : 18°15′E (SW of Table Bay), 158 metres ; 1 specimen.

Affinities. The d.d. is only 1·1 mm. The mouth plates are immature with the first ventral arm plate and second oral tentacle superficial. The distal oral papilla is present but the second one is not yet developed, leaving a diastema between the distal papilla and the first one, which is close alongside the apical papilla (or outermost tooth). The disc is armed with relatively long trifid stumps. The radial shields are not visible. The oral papillae are markedly rugose and many of the arm spines have lateral thorns for about the basal one-third or half of their length. The lateral plates are very moniliform (constricted proximally and flared distally) and their texture is striated like that of the small ventral arm plates. It is this last character particularly which suggests affinity with *Ophiacantha striolata*. Neither Koehler (1923) nor Cherbonnier (1962) mentioned striations on the arm plates of *Ophiacantha angolensis*, while a specimen of *Ophiacantha baccata* of similar small size already has oral papillae like those of the adult, even to the third one being distinctly coarser than the second. However, it does have relatively large trifid stumps on the disc and the proximal arm spines are similarly thorny in their basal halves. In *O. baccata* the arm plates are not striated.

If this specimen can be referred to *Ophiacantha striolata*, then it extends the range of the species westwards, other records being from the Durban area (Mortensen) and a new one from off East London (SCD 297F, 33°09′S : 28°02′E, 84 metres).

### ***Amphilimna cribriformis*** sp. nov.

Fig. 1

Material. NAD 33B, 29°38′S : 31°36′E (NE of Durban), 200 metres ; 1 specimen ['Anton Bruun' st. 390G].

NAD 35W, 29°35′S : 31°38′E, 150 metres ; 1 specimen [St. 390L].

NAD 40V, 29°34′S : 31°39′E, 118 metres, 17 specimens including the holotype. [St. 390P.]

NAD 43G, 29°34′S : 31°39′E, 115 metres ; 2 specimens [St. 390N].

NAD 52E and 55C, 29°29′S : 31°45′E, 86 metres ; 22 specimens [St. 391C & B].

PED 19J, 25°07′S : 34°34′E (between Delagoa Bay and Inhambane, Mozambique), 112 metres, 4 specimens [St. 372L].

Description. The holotype has the disc somewhat distorted in preservation, having d.d. 5·5–6·5 mm. It is similar to that of *Amphilimna olivacea*, having fine indistinct scaling with scattered slender tapering spinelets, in this specimen up to c. 0·5 mm long. The radial shields are narrow, length : breadth c. 0·8 : 0·15 mm, contiguous for most of their length but separated by a (possibly unnatural) notch distally. The upper end of the genital plate just distal to each shield is armed with a pair of tapering spines stouter than the disc spines.

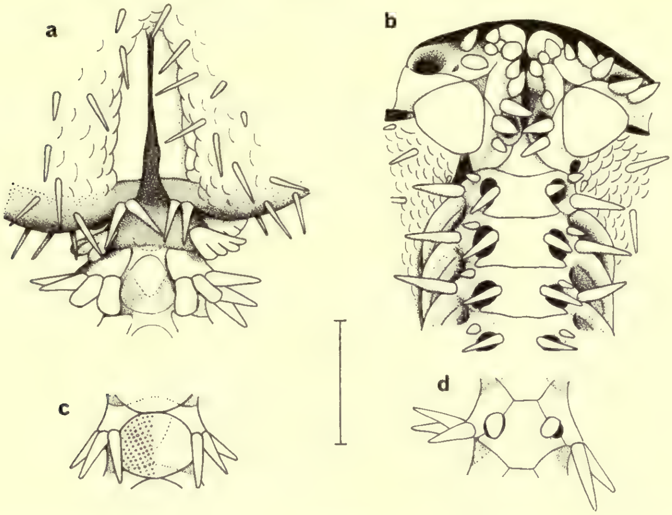

FIG. 1. *Amphilimna cribriformis* sp. nov. Holotype. NAD 40V. a. Dorsal view of part of disc (apparently incompletely regenerated) and two arm segments which would normally be overlain by the disc, showing transitionally modified upper arm spines and rudimentary, non-contiguous dorsal arm plates. b. Two jaws and the first few arm segments, the distal oral papillae omitted from the series on the extreme left, the indistinct sutures between the ventral and lateral arm plates proximal to the tentacle pores not drawn in. c and d. Dorsal and ventral views of the twelfth free arm segment, the perforations in the dorsal arm plate only drawn on half the plate ; the lines of dashes indicate the underlying vertebrae seen by transparency. The scale measures 1 mm.

The oral shields are rounded triangular, broadest distally and about as long as broad, the adorals widely separated from each other by the width of the rounded proximal angles. The oral plates are long. On each jaw there are two to four asymmetrically placed apical papillae superficial to the outermost broad, rounded tooth and flanked on each side by an almost superficial, elongated oral tentacle scale filling in the diastema between the apical group of papillae and the three spiniform distal papillae each side, the two outer of which arise from the edge of the adoral shield.

The disc appears to have shrunk back from the bases of the arms slightly since the dorsal arm plates of the first few free segments are rudimentary and their upper arm spines are very flat and abbreviated, though not fused together like those of the basal segments adjoining the genital slits. The succeeding dorsal arm plates become broader than long, approximately ovate, but still thin and semi-transparent, having a sieve-like appearance (hence the specific name) owing to the single layer of perforations. The underlying parts of the lateral arm plates and vertebrae can accordingly be discerned, at least when wet.

The first ventral arm plate is fairly large, its superficial part appearing triangular and swollen ; the distal edge is convex. The second plate has the distal edge almost straight and is relatively broad between the tentacle pores but the following plates soon become narrow in the proximal part, flare out abruptly distal to the pores and rejoin the lateral plate each side, while the distal edge sweeps back each side for more than a third of its extent.

On the first seven segments all the spines but the lowest of each series are modified into a wing-like flange, as also in *Amphilimna olivacea.* Beyond the disc the arm spines are still flattened but separate, tapering to sharp tips ; they number up to six and none exceed the segment in length. Owing to the flattening, their internal cavities are small.

The first eight to ten segments have two tentacle scales to each pore, a short proximal one on the lateral arm plate, at first almost in series with the lowest spine and itself resembling a short stumpy spine, while the second scale is based on the ventral arm plate about half-way along the side of the pore and is at first long and spiniform but soon becomes reduced and lost altogether by about the tenth (rarely the twelfth) segment ; simultaneously the proximal scale becomes flattened and shifts to the edge of the pore, adopting the more usual lid-like form.

AFFINITIES. In comparison with *Amphilimna olivacea* from both sides of the tropical Atlantic and adjacent coasts, recently redescribed and figured by Cherbonnier (1962), Thomas (1967), Madsen (1971) and Thomas & Schoener (1972), this new species from the Indian Ocean side of southern Africa differs in the following ways : the presence of usually two well-developed spines at the upper end of each genital plate rather than one ; the triangular shape of the oral shields with a flattened distal side rather than the rhombic shape so constantly found in *A. olivacea,* with the adorals widely separated rather than contiguous (or nearly so) interradially ; the more asymmetrical apical oral papillae, usually numbering three or four, sometimes two, rather than usually only two ; the greater breadth of the dorsal arm plates and their delicacy ; and the lesser elongation of the arm spines, not exceeding the segment length.

I agree with Thomas (1967) that the genus *Amphilimna* does not belong in the family Amphiuridae. He has ranged it instead in the Ophiacanthidae, which is rather a heterogeneous assemblage and badly in need of revision. Some of its members show considerable affinity with the Chilophiurida, including the Ophiocomidae and Ophionereidae.

## Family **AMPHIURIDAE**

### ***Amphiura albella*** Mortensen

*Amphiura albella* Mortensen, 1933a : 359–361, fig. 67.

MATERIAL. ABD 12H, 30°09'S : 31°37'E (E of Durban), 930 metres ; 1 specimen ['Anton Bruun' st. 389E].

This specimen has d.d. 6·0 mm, compared with 5 mm in the holotype. It differs in having the radial shields relatively larger, their length almost equal to half the disc radius, length : breadth c. 1·4 : 0·5 mm = 2·8 : 1. One radius is abnormal with a single very broad radial shield. There are five arm spines proximally, compared with four in the type. There are two tentacle scales only on the proximal parts of the arms, the remaining pores having only the one on the lateral arm plate.

## *Amphiura candida* Ljungman

Fig. 2

*Amphiura candida* Ljungman, 1867 : 318–319 ; Mortensen, 1933a : 361. [Non *A. candida* : Marktanner-Turneretscher, 1887, nec Koehler, 1904a.]
*Amphiura kalki* Balinsky, 1957 : 3–5, fig. 1, pl. 1, figs. 1, 2 ; A. M. Clark *in* Clark & Rowe, 1971 : 80, 97.

MATERIAL. MOR 50C, c. 23½°S : 35½°E (Morrumbene estuary, Mozambique), 3–5 metres ; 9 specimens.

MOR 131Y, same locality, 2 metres ; 2 specimens.

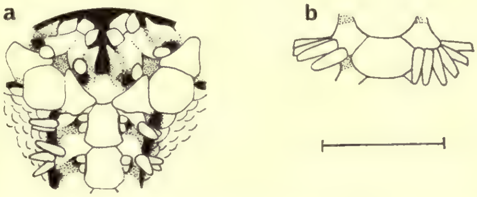

FIG. 2. *Amphiura candida* Ljungman. MOR 50C. D.d. 5·0–5·5 mm. a. Two jaws and the first two arm segments ; most jaws have more or less offset apical papillae, not fully infradental, as in the one on the left ; the distal oral papillae are all foreshortened. b. Dorsal view of twentieth free arm segment showing the truncated, slightly hooked, middle arm spines. The scale measures 1 mm.

NOMENCLATURE. Mortensen's unilateral declaration of the name *Amphiura candida* as a 'species delenda' has no validity without supporting action by the International Commission on Zoological Nomenclature, under the code of which the designation of a Japanese specimen as neotype by Koehler (1904) is also invalid. Since the type locality is Mozambique – for long a neglected collecting area – and not South Africa, the absence of the species among the South African collections studied by Mortensen is not surprising. It is unfortunate that Balinsky accepted at face value Mortensen's rejection of the name *A. candida* and so introduced the new name *Amphiura kalki*, which is surely synonymous. He himself 'had no criterion for distinguishing it from *A. candida*'.

The Morrumbene specimens agree with Ljungman's description as far as that goes, except that the distal oral papilla is not really squamiform, being quite thick, though short and slightly broadened with a rounded end. It arises from the distal end of the oral plate just adjacent to the edge of the adoral shield. Unfortunately Ljungman omitted to mention the arm spines, which have the distinctively large number of up to eight.

## *Amphiura capensis* Ljungman

*Amphiura capensis* Ljungman, 1867 : 320 ; Lyman, 1882 : 129, pl. 18, figs. 14–16 ; Koehler, 1908 : 634 : Döderlein, 1910 : 253–254, pl. 5, fig. 2 ; H. L. Clark, 1923 : 327 ; Mortensen, 1933a : 348–350.

? *Amphiura angularis*: H. L. Clark, 1923: 327–328; Mortensen, 1933a: 354. [Non *A. angularis* Lyman, 1879.]

*Amphiura adjecta* Mortensen, 1933a: 355–357, fig. 62.

*Amphiura compressa* Mortensen, 1933a: 357–358, figs. 63, 64.

MATERIAL. LU 53Y, Luderitz Bay (c. 26½°S : 15°E), shore; 2 specimens.

SWD 86G, 27°30′S : 15°25′E (S of Luderitz Bay), 35 metres; 7 specimens.

HB 5D, Hondekl'p Bay (c. 30°S : 17°E); 3 specimens.

PP 4S, Paternoster (c. 32°S : 17°E), shore; 1 specimen.

SB 176D, 178X, 187A, 188F, 205P, Saldanha Bay (c. 33°S : 18°E), 13–15 metres; 16 specimens.

LB 116, 524Q, 555B, Langebaan Lagoon (c. 33°S : 18°E); 7 specimens.

TRA 76N, 32°41′S : 18°03′E (N of Saldanha Bay), 27 metres; 1 specimen.

TRA 132I, 34°19′S : 18°30′E (False Bay); 3 specimens.

FAL 19D, 453H, 457D, 467K, 493M, 505D, 578T, False Bay, 29–80 metres; 19 specimens.

TRA 102S, near Mossel Bay (34°S : 22°E); 1 specimen.

KKN 42Z, Buffalo Bay, near Knysna (34°S : 23°E), intertidal; 1 specimen.

SCD 155C, 34°03′S : 25°59′E (Algoa Bay), 85 metres; 3 specimens.

SCD 294H, 33°04′S : 27°57′E (near East London), 84 metres; 6 specimens.

SCD 323C, 34°15′S : 25°50·5′E (S of Algoa Bay), 108 metres; 1 specimen.

SCD 365E, 33°50·7′S : 25°47·5′E (Algoa Bay), 36 metres; 1 specimen.

VARIATION. Like H. L. Clark I cannot distinguish specifically between specimens from deeper water down to c. 180 metres (as at 'Challenger' st. 141) and those taken by shore collecting. The only possibly significant difference found in a detailed examination of 24 specimens was in the length of the radial shields in relation to the disc radius, the ratio being 1 : 3·5 and 1 : 3·2 in two out of the three 'Challenger' specimens compared with a range of 1 : 2·2–2·8 in 21 of the Ecological Survey specimens from depths down to only 84 metres. However, the third 'Challenger' specimen (d.d. 5·8 mm) has the ratio 1 : 2·7.

I counted up to only seven arm spines in the 'Challenger' specimens and I suspect that the presence of eight in Lyman's figure was an artist's mistake. The maximum number of spines basally tends to increase with size from five at d.d. <4·5 mm to seven at >8 mm, though there is some individual variation. The upper spines at least are distinctly flattened, usually broadest at about the middle of their length but slightly tapering in smaller specimens, as in the holotype of *Amphiura adjecta* with d.d. 4 mm, or conversely spatulate with the tip more or less truncated or even expanded like an axe-head, as in the large holotype of *A. compressa* (d.d. 11 mm). The length of the longest spines is 1·0–1·4 (normally 1·1 or 1·2) times the segment length, compared with 1·5 times as long in the spines of the holotype and paratype of *A. angularis* Lyman from south of the Antarctic Convergence, which also number up to only five, even though d.d. is as much as 9·2 and 7·5 mm, and are tapering, though the middle ones are blunted at the tip.

Although H. L. Clark and Mortensen have both referred some South African specimens to *Amphiura angularis*, the latter realized in 1936 that these were distinguished from the type material by having the disc scaled ventrally rather than abruptly naked below with only a few scattered scales. In fact, I find that nearly all the South African specimens which I am attributing to *A. capensis* have the scaling deficient in a small area immediately distal to the oral shields, as Mortensen shows in his figure of *A. adjecta*. Only three specimens show perfectly continuous scaling; conversely six specimens have larger bare areas ventrally, one of them (from south of Luderitz Bay – the northernmost locality) has an abrupt edge to the scaling below the ambitus, though another from the same station has more extensive ventral scaling.

Another variable feature is the occurrence of a distinct primary rosette on the disc, which occurs in only about half the specimens; anyway the rosette decreases in relative size with growth. It is possible that the variable occurrence of the rosette as well as the differences in the ventral scaling can be attributed to the viviparous habit, which may render the disc more than usually liable to deformity, rupture or loss and regeneration.

The shape of the distal oral papilla is always somewhat elongated but varies from blunted conical to flattened; only occasionally is it more acute.

Growth changes include modifications in the shape of the ventral arm plates. These usually have a straight distal edge but it is convex in the smallest specimens, as in the type of *Amphiura adjecta*, while three specimens (two of them relatively large) have the edge slightly concave, as in the type of *A. compressa*.

The adoral shields are contiguous interradially in the smallest specimen studied (d.d. 2·5 mm), again as in the holotype of *Amphiura adjecta*, and almost so in several of the other smaller specimens, but distinctly separate in the majority.

The least number of scales on a line between the radial shields interradially increases from four to seven at d.d. <4 mm to c. 20 at 10·8 mm, with usually 9–13 at d.d. 5–7 mm. Again there is some individual variation.

There is a tendency for reduction in the relative length of the radial shields with growth, as usual in amphiurids, but only to the extent of changing the mean from 1 : 2·6 to 1 : 2·5 when the larger Survey specimens (d.d. 5 mm or more) are treated separately from the smaller ones. The length : breadth ratio of the radial shields changes from a mean of 2·35 : 1 in 12 specimens with d.d. <5 mm to 2·60 : 1 in a similar number of larger specimens.

Considering all these variable characters, I find myself quite unable to distinguish the four species recognized by Mortensen and consequently am referring both *Amphiura adjecta* and *A. compressa* to the synonymy of *A. capensis*, simultaneously restricting *A. angularis* to antarctic specimens.

### ***Amphiura grandisquama natalensis*** Mortensen

Fig. 3

*Amphiura grandisquama* var. *natalensis* Mortensen, 1933a: 353–354, fig. 60.

MATERIAL. ABD 1G, 29°21′S : 31°58′E (NE of Durban), 370 metres; 5 specimens. ['Anton Bruun' st. 358C.]

These specimens are all very small, d.d. <3·5 mm, and are notable for the extreme length of the lowest arm spine, sometimes equalling the length of three segments. The single, relatively large, tentacle scale appears rounded in contrast to the rather pointed scales illustrated by Mortensen (1933b) in a specimen from St Helena. The oral plates are distinctly flattened so that the proximal end of the first oral tentacle scale is on the same level as the infradental papilla and the second tentacle is almost superficial, approaching the structure of *Amphilepis* except that the teeth are broad.

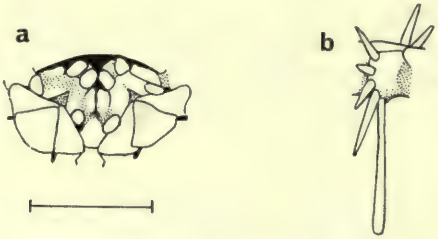

Fig. 3. *Amphiura grandisquama natalensis* Mortensen. ABD 1G. D.d. 3·25 mm. a. Two jaws. b. Side view of seventh free arm segment, the middle spines foreshortened. The scale measures 1 mm.

## ***Amphiura simonsi*** A. M. Clark

Fig. 4

*Amphiura simonsi* A. M. Clark, 1952 : 215–217, fig. 2.

Material. FB 1056C, FAL 64T, 96Z, 188W, 206E, 210Q, 234H, 374H, 395D, 419C, 422C, 447D, 450A, 703B, 804N, False Bay, 27–75 metres ; 36 specimens but only 16 of them with discs.

SCD 94R, 34°21′S : 25°41′E (SW of Port Elizabeth), 110 metres ; 1 discless specimen.

SCD 114V, 34°29′S : 21°49·5′E (SW of Mossel Bay), 73 metres ; 1 discless specimen.

SCD 119C, 34°33′S : 21°52′E, 76 metres : 1 discless specimen.

SCD 209C, 33°58·8′S : 25°42·2′E (Algoa Bay), 27 metres ; 2 specimens with discs detached, but present.

NAD 85C, 29°10′S : 31°51′E (S of Richards Bay), 42 metres ; 1 discless specimen. ['Anton Bruun' st. 356G.]

Description. The holotype of this species was also from sample FB 1056 but lacked the disc. A complete specimen from this sample was only sent to me later. Its disc is partially detached and rather deformed but probably measured between 6 and 7 mm in diameter. The oral frame (from distal edge of an oral shield to the distal edge of the first ventral arm plate opposite it) measures 2·0 mm. The radial shields are relatively small, c. 0·9 mm long and 0·3–0·4 mm broad ; they are contiguous only at the distal end and diverge proximally. The rest of the upper side of the disc is covered with small, even-sized scales and the primary plates cannot be

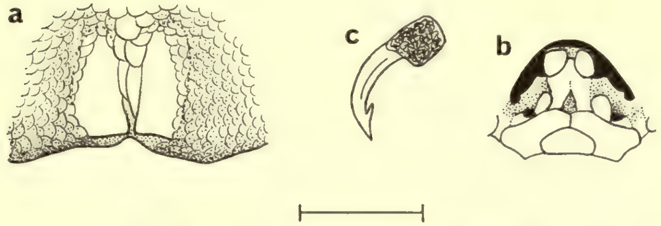

Fig. 4. *Amphiura simonsi* A. M. Clark. 'Topotype.' FB 1056C. D.d. 6 mm (oral frame diameter 2·0 mm). a. Dorsal view of part of semi-detached disc, the scaling very transparent and the abradial limits of the radial shields seen by transparency shown by dashes. b. One jaw showing the ill-defined limits of the outer of the two distal oral papillae each side. c. Fully modified middle arm spine with barb in this specimen. The scale measures 1 mm for a and b and 0·5 mm for c.

distinguished. The ventral side is abruptly more flexible and appears to be completely lacking in scales.

The outer of the two distal oral papillae is less well developed than the inner one and may be more of an extension of the rim distal to the second oral tentacle than an articulated papilla. The oral tentacle scale is small and rounded, not projecting much from the side of the oral plate, and well within the slit.

There are four arm spines proximally, the lowest one somewhat flattened and tapering to a blunt or rounded tip, half as long again as the segment ; the second spine gradually develops the conspicuous glassy hook beyond the base of the arm, its complete modification being reached by about the fortieth segment, where it shows an abrupt constriction after the opaque basal part ; the transparent hook is armed with a barb, not found in the holotype. The two upper spines are extremely flat and paddle-shaped or elliptical, widest in the middle or distally, with the tip broadly rounded. As many as twelve of the basal segments may lack the single tentacle scale, compared with only two in the holotype.

### ***Amphiura*** sp. indet. A.

Material. SCD 323C, 34°15′S : 25°50½′E (S of Algoa Bay), 108 metres ; 1 small, damaged specimen.

The disc is very distorted. The radial shields seem relatively long and were probably only contiguous distally. The disc was probably bare below. There are two spiniform distal oral papillae each side of the jaw, of which the outermost and largest arises from the adoral shield, while the other is on the distal end of the oral plate, separated from the infradental papilla by a diastema revealing the oral tentacle scale in the slit. The oral formula is m,om,m + t. The oral shields are rhombic and the adorals, with the exception of one contiguous pair, are just separate inwardly. The dorsal arm plates are almost circular, though the distal edge is slightly flattened medially. There are four short, stout, blunt arm spines and one poorly calcified tentacle scale.

### ? *Amphiura* sp. indet. B

MATERIAL. NAD 40Z, 29°34′S : 31°39′E (NE of Durban), 118 metres ; 1 discless specimen ['Anton Bruun' st. 390P].

This specimen again has two distal oral papillae but rounded, not spiniform and the inner one of them arises partly from the adoral shield so that the formula is $\mathrm{m,o\overline{n,n}m+t}$. It has some resemblance to *Amphiura koreae* Duncan. The dorsal arm plates are broad, oval. There are three acute arm spines and one tentacle scale, unlike *A. koreae*, which has two.

### ? *Amphiura* sp. indet. C

MATERIAL. FAL 416G, 34°12·5′S : 18°37′E (False Bay), 48 metres ; 1 oral frame and arm bases and a detached disc, ? of the same specimen.

The disc has very long narrow radial shields equal to about half the radius and was probably bare below. The oral shields are very short and broad, the adorals relatively large and broadly contiguous. There is one short rounded distal oral papilla. The four arm spines are extremely flat. The proximal pores are scaleless but then a narrow scale develops along the edge of the ventral arm plate.

### *Amphipholis similis* Mortensen

Fig. 5a

*Amphipholis similis* Mortensen, 1933a : 363–364, fig. 69.

MATERIAL. TRA 59F, off Bull Point (c. 34°S : 21°E), 70 metres ; 1 specimen.

SCD 144N, 34°46′S : 22°05′E (S of Mossel Bay), 93 metres ; 1 specimen.

NAD 46C, 29°35′S : 31°42′E (NE of Durban), 138 metres ; 1 specimen ['Anton Bruun' st. 390S].

This species is liable to confusion with small specimens of *Amphioplus* (*Lymanella*) *integer* with the fourth oral papilla undeveloped or more or less completely concealed behind the enlarged third one. However, the *Amphipholis* can be distinguished by the third papilla being much more than twice as broad as the second, markedly broader than in *A. integer*. Also the tentacle scales are not so much enlarged in *Amphipholis similis* and the arm spines are all shorter than the segment and taper more.

All three specimens are small with d.d. not more than 3 mm, the size of the holotype, but the one from Natal has four arm spines proximally, whereas the holotype had only three as also in *Amphioplus* (*Lymanella*) *integer* at all sizes.

### *Amphipholis strata* Mortensen

Fig. 5b–d

*Amphipholis strata* Mortensen, 1933a : 361–363, fig. 68, pl. 19, fig. 20.

MATERIAL. FAL 216W, 467L, 493M, False Bay (c. 34°S : 18½°E), 29–42 metres ; 5 specimens.

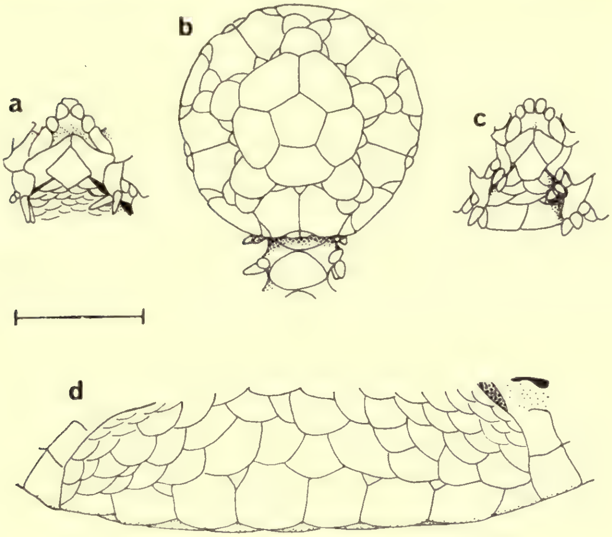

FIG. 5. a. *Amphipholis similis* Mortensen. NAD 46C. D.d. 3 mm. One jaw. b–d. *Amphipholis strata* Mortensen, b and c. FAL 467L. D.d. 1·9 mm. b. Dorsal view of whole disc and one arm base. c. One jaw and the adjacent interradius. d. FAL 493M. D.d. 7·0 mm. Ventral view of disc edge between two radii from which the entire arms have been lost. The scale measures 1 mm.

TRA 132G, 34°19·6′S : 18°30·5′E (False Bay), depth? ; 4 specimens.
MB 74J, 77G, 34°09′S : 22°07′E (Mossel Bay), 12–24 metres ; 2 specimens.
SCD 155D, 34°03′S : 25°59′E (Algoa Bay), 85 metres ; 1 specimen.

DESCRIPTION. All but one of the False Bay specimens are fairly large with d.d. >6 mm. Only interstitial scales occur between the plates of the rosette. At d.d. c. 6 mm there are usually only four scales in a line between the radial shields across each interradius, but six in the largest specimen (d.d. 8·5 mm).

A modification not noticed by Mortensen is the presence of a row of enlarged squarish disc scales just below the ambitus across each interradius, numbering eight, sometimes nine, in each area between the genital plates at d.d. c. 7 mm (fig. 5d). These are less noticeable in the largest specimens.

The oral frame is rather like that of *Amphioplus* (*Lymanella*) *integer* except for the absence of a fourth oral papilla and a more squared-off sculptured appearance of the three papillae with the third one particularly broad, as usual in *Amphipholis*.

The relatively long blunt-tipped arm spines are also reminiscent of *Amphioplus integer*.

The small specimen (fig. 5b, c) has d.d. only 1·9 mm ; its two intact arms measure 5·0 and 6·1 mm. It has a huge rosette on the disc without even interstitial scales between the plates and with only one row of very small scales between each primary radial and the relatively short broad radial shields. Interradially there are only two scales spanning the space between the radial shields distal to the primary interradial.

The row of square scales below the ambitus is even larger than in the adult specimens, occupying half the length of each ventral interradial area. The main difference from the larger specimens is in the extremely short arm spines, only about half as long as the segment.

At the same station in False Bay several young specimens of *Amphioplus* (*Lymanella*) *integer* of similar size were also collected. These differ conspicuously in having more numerous disc scales, the plates of the rosette already almost completely separated, while the uppermost scales of the ventral side of the disc are unmodified and the arm spines just exceed the segment in length. At d.d. 2 mm the fourth oral papilla is not yet developed in the young *A. integer*.

### ***Amphioplus (Lymanella) furcatus*** Mortensen

? *Ophiophragmus gibbosus* Ljungman, 1867 : 316.
*Amphiura incana* : Bell, 1905b : 258. [Non *A. incana* Lyman, 1879.]
? *Amphioplus gibbosus* : Koehler, 1927 : 21–23, pl. 4, figs. 5, 6.
*Amphioplus furcatus* Mortensen, 1933a : 370–372, fig. 75.

MATERIAL. NAD 83F, 29°10′S : 31°40′E (E of Tugela River mouth, N Natal), 33 metres ; 1 complete and 2 discless specimens ['Anton Bruun' st. 356C].
[Also 4 syntypes, Tugela River mouth, B.M. no. 1904.6.8.1–3.]

NOMENCLATURE. After studying numerous specimens from the Persian Gulf, Mortensen (1940, Danish Scientific Investigations in Iran, part 2 : 95–97) concluded that his *Amphioplus furcatus* is synonymous with *A. hastatus* from Mozambique and other tropical Indo-West Pacific localities. Although unfortunately most of the few specimens of *A. hastatus* in the British Museum collections are relatively small, d.d. <4 mm, I am not convinced that Mortensen was correct in this case. The four syntypes of *A. furcatus* and one Survey specimen which are complete with the disc all have relatively finer scaling and the radial shields relatively smaller, narrower and more tapering proximally than in the specimens of *A. hastatus* studied and the syntype figured by Koehler (1927, pl. 3, fig. 2). Also, contrary to Mortensen's description, two of his four syntypes do have the rosette just distinct though the plates are relatively small and widely separated, even in the smaller of the two with d.d. c. 3·3 mm, whereas in specimens of *A. hastatus* with the original disc the rosette is very conspicuous, its plates separated by only one line of scales. The two smaller specimens of *A. furcatus* have about 11 scales across each interradius along the shortest line between two neighbouring radial shields but those with d.d. 4 mm or more have about 13 such scales. These figures compare with minima of five scales in an Arabian specimen of *A. hastatus* with d.d. 3·25 mm (Clark & Rowe, 1971, fig. 24a) and seven scales in the figured syntype with d.d. 4 mm. Such discrepancies seem to me too large to overlook.

Yet another question of synonymy concerns the identity of the holotype and only known specimen of *Ophiophragmus gibbosus* Ljungman, 1867, type locality Port Natal, d.d. only 2·33 mm (2·5 mm according to Koehler). In the contiguous radial shields, four oral papillae, three arm spines and two tentacle scales, Ljungman's description of this species agrees both with *Amphioplus furcatus* and with *A. integer*

Ljungman, type locality also Port Natal. The presence of a rosette may be matched by both species at this small size, though it may be less conspicuous in *A. furcatus*. However, the description of the margin of the disc in *O. gibbosus* as having a row of rounded or tubercular papillae (as characteristic of the genus *Ophiophragmus*) fits with neither. It seems though that Ljungman made a mistake in so describing the margin of the disc since Koehler (1927) re-examined the holotype and could not find any marginal papillae or tubercles, the only modification being that the marginal scales were slightly elevated and projecting. This observation prompted him to remove the species to *Amphioplus*. The projection of the marginal scales could resemble the condition found in *A. furcatus*, where all five specimens with discs have the free edges of the uppermost row of ventral scales extended into spinose, sometimes bifid, projections. Thanks to the kindness of Dr P. A. Andersson I have been able to borrow the holotype of *A. gibbosus* from the Riksmuseum, Stockholm, but unfortunately it is now in an even worse condition than when Koehler saw it, badly decalcified with many of the superficial plates completely eaten away. At the same time I borrowed the holotype of *A. integer*, also collected at Port Natal by Wahlberg, which is in good condition. This fact in itself implies affinity of *A. gibbosus* with *A. furcatus*, even the recently collected Survey specimens of which are not strongly calcified, their arm plates being semitransparent, showing the underlying vertebrae beneath, in contrast to *A. integer*. Conversely, however, the arm spines of *A. gibbosus* were described as disproportionately stout by Koehler, agreeing with *A. integer*, not with the relatively slender tapering spines of *A. furcatus*. In view of this contradiction, coupled with the hopeless condition of the holotype, I think that it is best to reject the name *Ophiophragmus gibbosus*.

TABLE 3

Numerical data from the four syntypes (1, 2, 4 and 5) of *Amphioplus furcatus* with discs and one specimen from NAD 83 (3)

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Disc diameter (d.d.) | 5·2 | 5·0 | 4·0 | 3·7 | 3·3 |
| Radial shield length | 1·0 | 0·9 | 0·8 | 0·7 | 0·75 |
| Disc radius : radial shield length | 2·5 : 1 | 2·75 | 2·4 | 2·7 | 2·2 |
| Radial shield length : breadth | 2·4 : 1 | 2·6 | 2·5 | 2·3 | 2·3 |
| Minimum no. interradial scales | 13 | 13 | 13 | 11 | 11 |
| Arm segment length : spine length | 1·0 : 1 | 1·1 | 1·0 | 1·0 | 1·3 |

The number of interradial scales is from a linear series across the interradius between neighbouring radial shields. The spine lengths were taken from the middle arm spine of about the third free segment. [The small discrepancies in the ratios of disc radius to radial shield length compared with the figures above them are due to using the radial disc radius, which may be slightly less than half the diameter and to approximations in the conversion from micrometer scale units to the nearest tenth of a millimetre.]

### ***Amphioplus (Lymanella) integer*** (Ljungman)

Fig. 6

*Amphipholis integra* Ljungman, 1867 : 313.
? *Ophiophragmus gibbosus* Ljungman, 1867 : 316.

*Amphiura integra* : Koehler, 1904a : 65–66, figs. 16, 17.
*Amphioplus integer* : H. L. Clark, 1923 : 330–331 ; Mortensen, 1933a : 368–370, figs. 73, 74.
? *Amphioplus gibbosus* : Koehler, 1927 : 21–23, pl. 4, figs. 5, 6.
*Amphioplus* (*Lymanella*) *integer* : A. M. Clark, 1970 : 52.

MATERIAL. LAM 29H, 32°05′S : 18°17′E (Lambert's Bay), 20 metres ; 1 specimen.

SBS 33K, Lambert's Bay, 10 metres ; 1 specimen.

FAL 108E, 467L, 486E, 745P, False Bay (c. 34°S : 18½°E), 7–62 metres ; 21 specimens.

F 169, False Bay ; 1 specimen.

HM 8E, Hermanus (34°S : 19°E) ; 1 specimen.

CI 4D, Cape Infanta (34°S : 20°E) ; 1 specimen.

KKN 41Q, Buffalo Bay, near Knysna (34°S : 23°E), intertidal ; 1 specimen.

SCD 329A, 34°04′S : 23°23′E (E of Knysna), 22 metres ; 5 specimens.

SCD 260B, 33°48′S : 25°47′E (Algoa Bay), 26 metres ; 3 specimens.

LLL 8Y, East London (33°S : 27°E) ; 1 specimen.

MOR 39C, 41X, 44A, 49M, 50C, 51V, 70V, 77M, 107U, 115S, 117F, 127E, 128S, 164N, 168Q, 171E, Morrumbene estuary, Mozambique (23°S : 35°E) ; c. 55 specimens including some discless and others juvenile.

VARIATION AND SYNONYMY. There is considerable variation in the form of the disc, at least partly correlated with regeneration following its loss, the most obvious consequence of which is absence of the rosette. When regeneration is incomplete the radial shields are abnormally short. The scales may make a fairly smooth covering or they may be somewhat thickened and if the disc is flattened in preservation then the marginal scales at the junction between the dorsal and ventral ones tend to project, though they do not have the spinose prolongations found in *Amphioplus furcatus*. Koehler (1904) described the marginal scales of the small holotype of *Ophiophragmus gibbosus* Ljungman (from Port Natal like that of *A. integer*) as erect. As detailed under the heading of *A. furcatus*, it is debatable whether *O. gibbosus* is conspecific with that species or with *A. integer*. The holotype is now unrecognizable.

In 1971 (Clark & Rowe : 102–103), on the basis of some of the specimens from Morrumbene, I treated *Amphioplus integer* as a species with relatively narrow radial shields, thinking that Koehler's diagrammatic figure of the holotype (1904, fig. 16) showed them as shorter than reality, especially as Mortensen's specimen (also from Durban) has relatively longer shields, length : breadth c. 2·4 : 1. However, since the Cape Province specimens collected by the Ecological Survey now examined show some divergence in comparison with the Morrumbene specimens and both lots show considerable variation in shield shape and arm spine length, I borrowed the holotype of *A. integer* from the Riksmuseum, Stockholm, thanks to Dr P. A. Andersson. Its locality falls between the two groups of specimens geographically. The length : breadth ratio of its shields is only c. 1·9 : 1, Koehler's figure being actually fairly accurate in this respect, and since the rosette is present there is clearly no regeneration in process. This ratio falls within the range of 1·6–2·5 : 1 (mean 2·2 : 1) found in 18 specimens from around Cape Province, compared with a range of 2·3–3·7 : 1 (mean 2·8) for 15 specimens from Morrumbene.

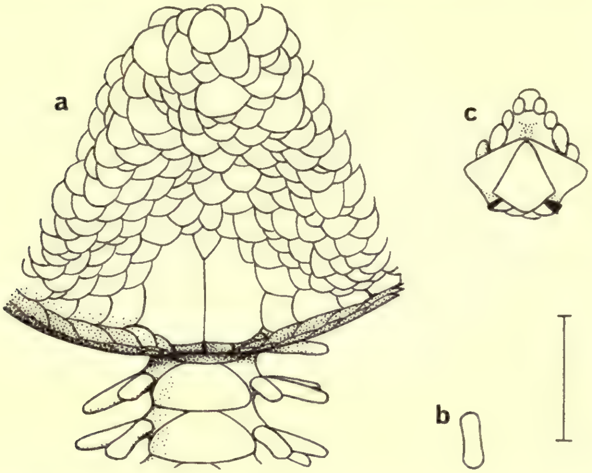

Fig. 6. *Amphioplus* (*Lymanella*) *integer* (Ljungman). Holotype. Port Natal. Stockholm Museum no. 771. D.d. 5 mm. a. Dorsal view of part of disc and one arm base. b. Uppermost arm spine viewed perpendicularly. c. One jaw. The scale measures 1 mm.

As for relative arm spine length, the maximum length of the middle spine compared with the length of the corresponding segment is 1·5 : 1 in the holotype, 1·4–1·8 (mean 1·6) : 1 in the Cape specimens and 1·0–1·25 (mean 1·1) : 1 in the Morrumbene specimens. The specimens from the False Bay area seem to have relatively the longest spines.

Possibly the strictly South African specimens with their broader radial shields and longer spines merit a subspecific distinction from those taken at Morrumbene. Unfortunately Balinsky (1957) does not comment on either of these characters in his specimens from Inhaca, midway between Durban and Morrumbene.

It should be noted that Koehler's 1904 figure of the holotype of *Amphioplus integer* exaggerates the shape and length of the uppermost arm spines, which in fact barely exceed the segment in length (Fig. 6b) and are flattened and only slightly expanded at the tip, appearing somewhat truncated when foreshortened but rounded when viewed from above. None of the other specimens I have studied have the uppermost spine modified to this extent.

### ***Amphioplus (Unioplus) falcatus*** Mortensen

Fig. 7

*Amphioplus falcatus* Mortensen, 1933a : 365–367, figs. 70, 71, pl. 19, figs. 18, 19.
*Unioplus falcatus* : Fell, 1962 : 16.
*Amphioplus* (*Unioplus*) *falcatus* : A. M. Clark, 1970 : 44, 49.

Material. ABD 15E, 29°42′S : 31°38′E (NE of Durban), 350 metres ; 1 discless specimen ['Anton Bruun' st. 390E].

NAD 31V, 29°37·5S : 31°33′E, 175–200 metres ; 1 specimen lacking arms [St. 390H].

NAD 35V (part), 29°35′S : 31°38′E, 150 metres ; 9 discless specimens and 4 discs [St. 390L].

NAD 46C, 29°35′S : 31°42′E, 138 metres ; 2 discless specimens [St. 390S].

Judging from this series of specimens, the normal oral formula in this species is clearly m,om,m + t, the tentacle scale rarely being quite in series with the oral papillae. Only on very occasional jaws is a fourth oral papilla present.

The great length of the radial shields, more than half the disc radius, and their sickle-shaped (falcate) form, with a distinct kink at about a quarter of the way from the distal end, is very conspicuous and in addition many of the scales have an orange patch, giving a peculiar spotty appearance. On one disc particularly the pigmented areas are also slightly elevated and the profile is correspondingly uneven. The arm plates and spines are also partially orange coloured.

The largest specimen has d.d. 10 mm.

This species is sympatric with *Amphioplus pectinatus* but the single elongated tentacle scale and the fewer oral papillae immediately distinguish it even if the disc with its unusual radial shields is lacking.

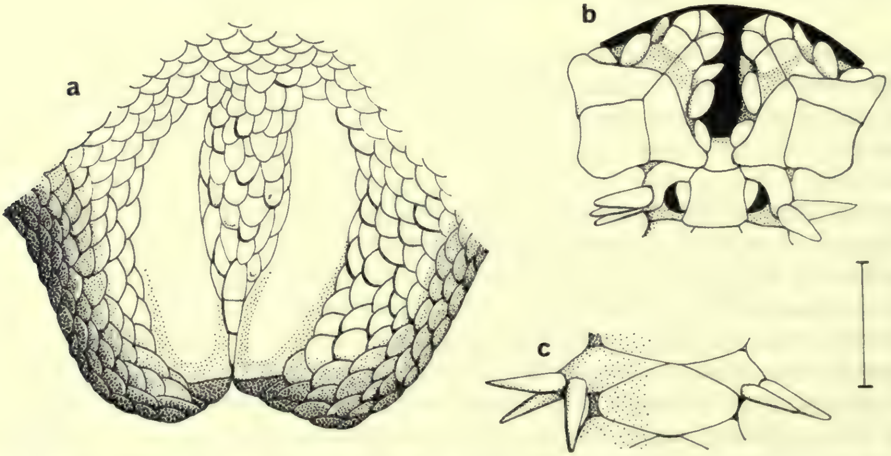

Fig. 7. *Amphioplus* (*Unioplus*) *falcatus* Mortensen. NAD 35V. a. Dorsal view of part of detached disc, d.d. 10 mm. b. Two jaws and the first arm segment. c. Dorsal view of twentieth free arm segment. The scale measures 1 mm.

### ***Amphioplus (Amphioplus) pectinatus*** Mortensen

Fig. 8

*Amphioplus pectinatus* Mortensen, 1933a, : 367–368, fig. 72.

Material. NAD 31W, 29°37·5′S : 31°33′E (NE of Durban), 175–200 metres ; 5 discless specimens and 1 disc, form A ['Anton Bruun' st. 390H].

NAD 35V (part), 29°35′S : 31°38′E, 150 metres ; 6 discless specimens, form A [St. 390L].

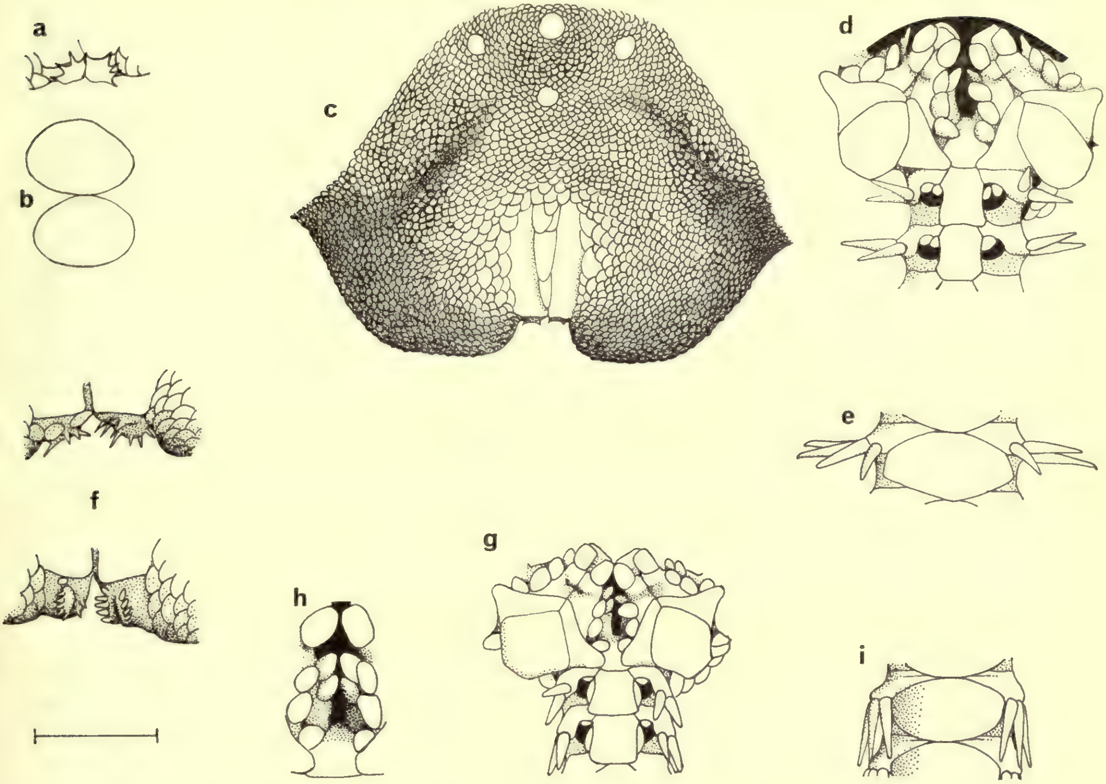

FIG. 8. *Amphioplus* (*Amphioplus*) *pectinatus* Mortensen. a and b. Holotype. Copenhagen Museum ; from sketches by Dr Madsen. a. Oblique view of disc radially showing 'combs' distal to the radial shields. b. Eighth and ninth dorsal arm plates. c–e. NAD 31V. Form A. c. Dorsal view of part of detached disc, d.d. c. 8 mm. d. Two jaws and first two arm segments. e. Dorsal view of fifteenth free arm segment. f–i. NAD 61R. Form B. f. Oblique radial views of two different detached discs. g. Two jaws and first two arm segments with h. Enlargement of oral slit between two jaws. i. Dorsal view of fifteenth free arm segment. The scale measures 1 mm for c–g and i and 0·5 mm for h.

NAD 46D, 29°35′S : 31°42′E, 138 metres ; 1 discless specimen, form A [St. 390S].

NAD 52C, 29°29′S : 31°45′E, 86 metres ; 3 discless specimens and 1 disc, form B [St. 391C].

NAD 55D, 29°29′S : 31°45′E, 86 metres ; 2 discless specimens and 3 discs, form B [St. 391B].

NAD 61R, 29°26′S : 31°46′E, 77 metres : 3 discless specimens and 4 discs, form B [St. 391F].

VARIATION. As indicated above, two forms, A and B, are now attributed to *Amphioplus pectinatus* from the Survey collections, the first from samples NAD 31W, 35V and 46D and the second from 52C, 55D and 61R. I am by no means sure that these are conspecific but, as none of the discs found are attached to oral frames, there is an element of doubt that they do correspond. In addition, the intact holotype of *A. pectinatus* with d.d. only 5 mm appears to have tentacle scales like form A but dorsal arm plates and discs as in form B. I am indebted to Dr Madsen of the Copenhagen Museum for comments on and sketches of Mortensen's two type specimens. He notes that Mortensen's fig. 72 is reasonably accurate except with regard to the projections distal to the radial shields in fig. 72b, which appear rather as in the detail in fig. 72c. Also Madsen's drawing of the eighth and ninth dorsal arm plates of the holotype shows them as more convex distally, being more nearly elliptical than triangular in shape, though in fact in the paratype (d.d. 4 mm) their shape is more triangular, agreeing with fig. 72b. The paratype also has the disc scaling fairly coarse and its rosette of primary plates is distinguishable. Both types have the second from outermost oral papilla distinctly enlarged and the smaller specimen has the distalmost papilla reduced in size. The oral tentacle scale (or second papilla) is superficial in the paratype and in series with the other papillae but in the holotype it is slightly inset. Incidentally, the longitude of the type locality is the subject of a printer's error and should have been 31°19′E, not 49′, from which station several other amphiurids including *Amphiolus falcatus* were also taken.

The differences between the two present forms are as follows :

| A | B |
|---|---|
| 1. First oral tentacle scale single (Fig. 8d) | 1. Usually two oral tentacle scales adjacent on the side of the oral plate, the proximal one sometimes almost superficial, the distal one tending to be hidden behind the second oral papilla (Fig. 8g) |
| 2. Dorsal arm plates with a more or less distinct median distal angle (Fig. 8e) | 2. Dorsal arm plates almost elliptical in shape, the distal side convex but flattened medially (Fig. 8i) |
| 3. Arm spines five on a few proximal segments (six in one specimen, d.d. 7 mm) | 3. Arm spines four on proximal segments, rarely five at d.d. 8 mm |
| 4. Some tentacle pores with only one scale rather than two ; the scale on the ventral arm plate short (Fig. 8d) | 4. All tentacle pores with two scales, the one on the ventral arm plate long and narrow (Fig. 8g) |

The eight discs of form B agree fairly well with that of the holotype of *Amphioplus pectinatus*. The scaling is somewhat finer but this is probably accountable to the fact that they are larger with diameter up to 8 mm. None of them show a primary rosette so it is possible that all may be regenerated rather than original discs, the species is clearly vulnerable to shedding of the disc. Distal to the radial shields on the outer end of the genital plate they all have the spinose projections which prompted the specific name ; these may be arranged irregularly but in one or two cases seem to be in paired vertically aligned combs (Fig. 8f, lower).

The single disc found in the samples of form A contrasts in having extremely small but very thick and projecting scales recalling those of the holotype and only known specimen of *Amphiura acutisquama* A. M. Clark, 1952, from the west coast of South Africa. However, the present disc is also unusual in having the six plates of the primary rosette showing as conspicuously larger than the central scales. In addition it has spinose projections distal to each radial shield, though these are not so well developed as in the discs from the samples of form B. The ratio of radial disc radius to radial shield length is 2·7 : 1, though if the ratio is calculated from half the disc diameter its value comes to 3·2 : 1 since the radial radius is markedly less than the interradial one owing to bulging of the disc. Length : breadth of the radial shields is between 4·0 and 4·5 : 1. These compare with ratios of radial radius : shield length of 2·0–2·5 : 1, the shields being relatively larger, on the discs of form B, with shield length : breadth 5–6 : 1. In spite of these differences, the coincidence of the development of the spinose processes on the genital plates indicates a close relationship. Also, in the type material of *Amphioplus pectinatus* the radius : shield length is about 3 : 1 and the scales are thick, though coarse.

## ***Amphioplus*** sp. indet. A (aff. ***A. falcatus***)

Fig. 9

Material. TRA 104L, 34°31′S : 19°21′E (near Hermanus), 22 metres ; 1 discless specimen.

MB 36B, 34°08′52″S : 22°09′19″E (Mossel Bay), 11·5 metres ; 1 discless specimen.
MB 37B, 34°09′18″S : 22°10′02″E, 31 metres ; arms.
MB 71F, 34°08′46″S : 22°07′20″E, 12 metres, 1 discless specimen.
MB 75F, 34°08′40″S : 22°07′26″E, 15·5 metres ; 1 discless specimen.
LIZ 13P, 33°58·2′S : 25°38·8′E (Port Elizabeth), 7–8 metres ; 2 discless specimens.
NAD 63Q, 29°21·6′S : 31°35·7′E (NE of Durban), 57 metres ; 1 discless specimen ['Anton Bruun' st. 391J].

Description. All these incomplete specimens appear to belong to an undescribed species. Without knowledge of the disc it seems unwise to give them a specific name.

The torn edges of some of the discs still attached to the oral shields indicate that scaling was present ventrally, though probably tenuous.

The largest specimen, from LIZ 13P, had d.d. c. 10 mm, judging from the extent of the missing dorsal arm plates basally. The oral frame measures 2·6 mm from the distal edge of one oral shield to the distal edge of the first ventral arm plate opposite. The oral shields are elongate hexagonal, broadest in the middle with the proximal and distal lobes broadly truncated. The adoral shields have a distal lobe between the oral shield and the adjacent lateral arm plate but are very short interradially and widely separated. The oral plates are sunken distally but sharply elevated proximally, increasing the vertical height of the jaw. Of the four oral papillae, the infradental is squarish but rounded at the corners. The second and third papillae both arise from the side of the oral plate and are finger-like in shape, about three times as long as broad. The short rounded fourth papilla arises from a proximal extension of the first ventral arm plate, not from the adoral. The oral tentacle scale is inset in the oral slit and is also finger-like but smaller than the second oral papilla which may hide it. The oral formula is m,mm, ,m + t.

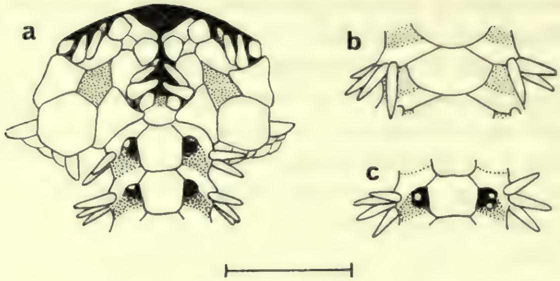

FIG. 9. *Amphiopus* sp. A (aff. *A. falcatus*). LIZ 13P. D.d. c. 10 mm. a. Two jaws and the first two arm segments. b and c. Dorsal and ventral views of fifteenth arm segment. The scale measures 1 mm.

The arms increase in width from a minimum of 0·75 mm proximally to 1·0 mm at about the sixtieth segment, by which they are all broken ; they were probably relatively long. The dorsal arm plates are approximately elliptical, though slightly broader towards the proximal end ; most of them are just contiguous or very slightly overlapping. The ventral arm plates are at first squarish, the proximal lobe being broadly truncated and the sides only slightly tapering ; they soon become almost hexagonal with the proximal lobe more prolonged and the distal tapering more markedly. The distal edge of the first two or three plates is slightly convex but it soon becomes straight and then develops a small notch in the middle. There are four arm spines on the entire length of arm remaining, all somewhat flattened but the uppermost one more so ; all taper more abruptly near the tip. The proximal spines are all slightly longer than the corresponding segment and those on the broader part of the arm are half again as long as the segment. There are no proper tentacle scales but in the skin covering many of the pores there are single or sometimes double calcareous accretions, well isolated from the ventral and lateral arm plates, which may be homologous with tentacle scales.

The second specimen from sample LIZ 13P is much smaller. Its oral shields are much shorter, broader than long, though the adorals are again widely separated. The arm plates are relatively narrower, as would be expected, the ventral arm plates longer than broad. The tentacle pores appear quite naked.

The other oral frames also show some variation in the shape of the oral shields, which may be circular, octagonal or pentagonal. There may be a small gap in the row of oral papillae between the first and second ones and in one specimen the two elongated middle papillae are flattened and slightly fluted. Distal portions of arms are unusual in that, although the arms taper, the segments remain broad and short instead of attenuating and the arm becomes very compact. The number of spines drops to three and the lowest one becomes relatively longer than the other two, up to twice as long as the segment. Some of the longer arm spines may have a very small terminal hook or a few divergent thorns.

The spiniform middle oral papillae, the broadly separated adoral shields, the reduction of the tentacle scales and the distally compact arms easily mark off this species from the other South African amphiurids.

### ? ***Amphioplus*** sp. indet. B

MATERIAL. PED 5S, 24°46′S : 35°18′E (S of Inhambane, Mozambique), 110 metres ; 1 specimen ['Anton Bruun' st. 371F].

D.d. is only 3·3 mm in this specimen and only part of one arm remains attached to the disc. In many ways it agrees superficially with *Amphipholis similis*, as figured by Mortensen, but the third oral papilla is only about twice as broad as long and is also very thick, while in some series there appears to be a fourth papilla behind the third one, as in young *Amphioplus* (*Lymanella*) *integer*. The shapes of the oral shields and arm plates agree with *A. similis* as well as with *A. integer* but the disc scaling is very thick, much more so than in the present material of either of the species named. There is no distinct rosette but this could be due to regeneration of the disc. Also the radial shields are all less contiguous than in the two species named, four pairs being separated for at least their proximal thirds and the fifth only touching at their distal ends. On the first two free arm segments there are four arm spines, then three. The two fairly large tentacle scales agree with those of *A. similis* but those of *A. integer* are even larger and usually somewhat angular.

If the oral papillae are only transitionally three, this with the broadness of the third and distalmost and the straightness of the papilla series suggests affinity with *Amphioplus* (*Lymanella*). However, the more or less separated radial shields and the somewhat smaller tentacle scales and fourth arm spine disagree with this.

Apart from South African species, this specimen also has some resemblance to *Amphioplus platyacanthus* Murakami, 1943, from the Caroline Islands, but that has the fourth oral papilla fully exposed at d.d. 3 mm. *Amphioplus* (*Amphichilus*) *ochroleuca* (Brock, 1888) also has thick disc scales and only three oral papillae fully developed but the third of these is no larger than the second and there is no sign of a fourth papilla underlying it, even at a larger size.

### ***Amphiodia*** sp. aff. ***A. microplax*** Burfield

? *Amphiodia* sp. Balinsky, 1958 : 10.

MATERIAL. NAD 67H, 29°21·6′S : 31°35·7′E (NE of Durban), 57 metres ; 1 discless specimen ['Anton Bruun' st. 391H].

NAD 78G, 29°19·1′S : 31°26·8′E, 38 metres ; 1 discless specimen [St. 392J].

NAD 85C, 29°10′S : 31°51′E, 42 metres ; 3 discless specimens [St. 356G].

These incomplete specimens have the oral shields relatively long and only a single tentacle scale. This accords with *Amphiodia* (*Amphispina*) *microplax* Burfield, known from the Red Sea and Persian Gulf, which also frequently loses its disc so that the presence of the modified marginal disc scales prolonged into spinose processes, characteristic of the subgenus *Amphispina*, cannot be ascertained. The other *Amphiodia* known from the western Indian Ocean – *A. dividua* Mortensen – has two tentacle scales, apart from being fissiparous and six-armed.

## ***Ophionephthys lowelli*** [*] sp. nov.

Fig. 10

MATERIAL. SCD 74S, 32°33′S : 28°38′E (NE of East London), 55 metres ; 2 specimens with discs, 2 loose discs and 21 discless specimens.

SCD 82P, 33°03′S : 27°54′E (East London), 51 metres ; 1 specimen.

DESCRIPTION. The holotype has the disc partly detached from the oral frame and rather shrunken. Judging from the extent of the incomplete proximal dorsal arm plates, its d.d. was c. 7·5 mm ; the diameter of the oral frame is 2·3 mm. The arms are all broken off short ; judging from the remaining material they were extremely long, well over ten times the d.d.

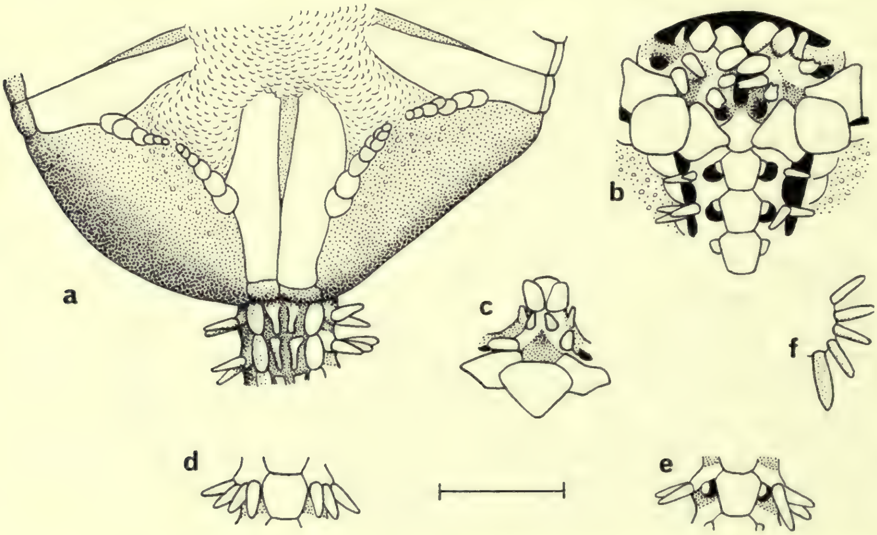

FIG. 10. *Ophionephthys lowelli* sp. nov. a, b. Holotype. SCD 74S. a. Dorsal view of part of disc (somewhat reconstructed) and base of one arm from which the disc has shrunk back revealing segments with the dorsal arm plates divided by erosion of the median part. b. Two jaws and the first two arm segments. c–f. Paratype. c. Jaw with oral shield truncated proximally. d–f. Dorsal, ventral and side views of twentieth arm segment. The scale measures 1 mm.

The upper side of the disc was probably covered with continuous extremely fine scaling, except towards the periphery where it turns brown when partially dried. However, there is a conspicuous row of enlarged scales extending interradially from the abradial edge of each radial shield at about half-way along its length. These belts do not appear to meet interradially but the shrinkage of the discs renders this uncertain. The radial shields have length : breadth 1·9 : 0·5 mm = nearly 4 : 1 and are contiguous in the distal half though narrowly separated proximally, at least in the preserved condition. The scaling at their proximal ends is a little more substantial than elsewhere. The ventral skin of the disc bears only scattered rudimentary scales and is more or less transparent.

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[*] Named after Lowell P. Thomas, whose fine work on the amphiurids of Florida (1962) includes a redescription of the type-species of *Ophionephthys*, *O. limicola* Lütken.

The oral shields are as long as broad ; the proximal lobe is almost semicircular but for a slight medial flattening and the distal lobe is distinctly angular. The adoral shields are widely separated interradially but have a broad distal lobe between the oral shield and the first lateral arm plate on each side. The oral plates are fairly long and sunken, without a proximal peak and the broad infradental papillae, as preserved, project almost vertically from their apical ends. There are two spiniform oral papillae on each side of the jaw, even the distal one distinctly separated from the adoral shield ; their tips are rugose and they also tend to project vertically. There is a small spiniform oral tentacle scale inset in the slit close to the teeth. The oral formula is m,mm,o + t.

The dorsal arm plates are bucket-shaped, tapering distally and relatively narrow, as long as broad or longer. The ventral arm plates are similar in shape, broadly overlapping, the distal edge convex. The lateral arm plates bear four spines, the lowest one about equal in length to the segment, the rest slightly shorter. There is one fairly long tentacle scale on each pore, equal in length to about half the length of the ventral arm plate.

VARIATIONS. The other oral frames show considerable variation in the shape of the oral shields, which may be rhombic but more often have the proximal lobe very reduced and flattened, with the adoral shields more widely separated than in the holotype. There are usually five arm spines on the proximal segments, of which the lowest slightly exceeds the segment length beyond the base of the arm and all are somewhat flattened and blunt-tipped ; under a high magnification they appear very finely ridged.

Although there is some variation in the size of the oral papillae, their number seems fairly constant ; only in one specimen do most of the jaws lack the second papilla. None were seen to have a fourth papilla on the adoral shield.

AFFINITIES. The combination of normally two oral papillae on each side of each oral plate with an oral tentacle scale in addition and the presence of belts of enlarged scales contrasting with extremely reduced scaling elsewhere on the disc indicate that this species is congeneric with *Ophionephthys limicola* Lütken, the type and only species of that genus since I reviewed it in 1970. The only discrepancy from my diagnosis of the genus is the minor one of the somewhat more extensive, though still very reduced, disc scaling. *O. limicola* is known from the West Indies. Geographically much closer and morphologically nearly as similar is the species from Madagascar recently described by Cherbonnier (1972) as *Amphioplus polymorphus*, which likewise has belts of enlarged disc scales extending interradially from the radial shields. Cherbonnier made no comparison of *A. polymorphus* with *O. limicola*, only with those species which Fell had referred to *Ophionephthys* in 1962 and I had transferred to *Amphioplus*, presumably because *A. polymorphus* seems consistently to have a fourth oral papilla present on the adoral shield, although its jaws are otherwise rather variable. Cherbonnier compared it also with the West Indian *Amphioplus coniortodes* H. L. Clark, 1918, which, incidentally, is sympatric with *O. limicola*. It is noteworthy that the two West Indian species both have almost keyhole-shaped oral shields proximal to which the adorals meet broadly, whereas both *Ophionephthys lowelli* and *A. polymorphus* have the proximal lobe of the oral shields more or less reduced and the adorals widely separated. The relationships of all four will bear future study.

Apart from the difference in the oral and adoral shields, *Ophionephthys lowelli* differs from *O. limicola* in the spiniform shape of the second and third oral papillae, the more elongate dorsal arm plates and the blunter arm spines, though the more extensive disc scaling of the holotype may be subject to variation, as in *Amphioplus polymorphus*, which likewise has the papillae on the side of the oral plates elongated and the arm spines blunted. Clearly *Ophionephthys lowelli* occupies an intermediate position.

### ***Amphilepis scutata*** Mortensen

*Amphilepis scutata* Mortensen, 1933a : 372–373, fig. 76.

MATERIAL. NAD 31X, 29°37·5′S : 31°33′E (NE of Durban), 175–200 metres ; 1 specimen ['Anton Bruun' st. 390H].

D.d. is only 3·3 mm compared with 5 mm in the holotype. The radial shields are relatively smaller, more widely separated interradially and more tapering proximally than shown in Mortensen's figure, so that the widest part is near the distal end, not in the middle. Even the first two ventral arm plates are not contiguous at this size.

## Family **OPHIACTIDAE**

### ***Ophiactis plana*** Lyman

*Ophiactis plana* Lyman, 1869 : 330–331 : H. L. Clark, 1923 : 333 : Mortensen, 1933a : 345–346, fig. 57 ; H. L. Clark, 1939 : 76–77.

? *Ophiactis lymani* Ljungman, 1871 : 629 ; Mortensen, 1933b : 442–449, figs. 15a–d, 16d, e ; Balinsky, 1957 : 14.

? *Ophiactis parva* Mortensen, 1926 : 123–124, fig. 12 ; Balinsky, 1957 : 15.

*Ophiactis flexuosa* (part) Lyman, 1882 : 116 ('Challenger' st. 142).

MATERIAL. SST 12L, M, 35°22′S : 22°31′E (SSW of Knysna), 200 metres ; 3 specimens.

SCD 155K, 34°03′S : 25°59′E (Algoa Bay), 85 metres ; 1 specimen.

SCD 177D, 34°20′S : 23°31′E (SE of Knysna), 110 metres ; 1 specimen.

SCD 203G, 34°51′S : 23°41′E, 184 metres ; 1 specimen.

SCD 249E, 34°48′S : 23°39′E, 146 metres ; 2 specimens.

NAD 15N, 30°47′S : 30°27·5′E (S of Durban), 36 metres ; 1 specimen.

NAD 27F, 29°53·5′S : 31°57·7′E (E of Durban), 71 metres ; 3 specimens.

NAD 81R, 29°11·5′S : 31°37′E (NE of Durban), 18 metres ; 2 specimens ['Anton Bruun' st. 356B].

DBN 238K, Durban Harbour entrance, LWST ; 2 specimens.

Most of these specimens are very small, d.d. <3 mm. The only one larger than this lacks spinelets on the disc but these are present in small numbers in one or two of the other specimens and show a small hyaline terminal point, much as in Mortensen's figure (1933b) from the specimens from St Helena which he refers to *Ophiactis lymani*. In addition the South African specimens resemble the West Indian holotype of *O. lymani* in having slightly concave distal edges to the ventral arm plates, unlike Mortensen's specimens. Lyman described the distal edges of these plates in *O. plana* as simply 'curved', presumably convex since he did not qualify it with 're-entering'.

In his St Helena paper Mortensen (1933b) made no reference to *Ophiactis plana*.

Both Mortensen (1933a) and Madsen (1971) have commented on the close similarity between the West African *Ophiactis luetkeni* Marktanner-Turneretscher and the South African *O. carnea* Ljungman, both with five arms and more or less ovate dorsal arm plates. However, the parallel resemblance between the geographically corresponding *O. lymani* and *O. plana*, both with six arms and fan-shaped dorsal arm plates, escaped them. The naming of South African specimens as *Ophiactis plana* follows from Lyman's comment (1882) that some collected on the Agulhas Bank by the 'Challenger' were 'scarcely to be distinguished' from *O. plana* though, for some reason, he referred them provisionally to *O. flexuosa*, simultaneously described from north of New Zealand. Mortensen accepted H. L. Clark's usage of the name *O. plana* for South African material as he assumed that Clark would have compared them with Lyman's type material, also in the Harvard Museum, from the West Indies.

Surprisingly, Lyman (1869) made no mention of the arm number, when describing the type material of *Ophiactis plana*, or again in his 'Challenger' report where he gave a synopsis of the species of *Ophiactis*. Only his comment about the six-armed South African specimens resembling *O. plana* implies that this number was also found in the type material. H. L. Clark also gave little weight to the number of arms as a specific character in the genus *Ophiactis* and in 1915 made no comment when he illustrated as *O. plana* a six-armed specimen from off Georgia. Mortensen (1933a) assumed that this was one of the type specimens but they were from the Florida Strait area.

Mortensen (1940) contested H. L. Clark's provisional reference of *Ophiactis parva* from the Suez Canal to the synonymy of *O. plana* in 1939 but the diminutive type material shows little in the way of definitive characters to justify distinguishing it specifically in my opinion.

REGENERATION. The specimen forming sample SST 12M is extraordinary in that it has five arms altogether with one old arm and four regenerating.

## Family **OPHIOTRICHIDAE**

### ***Ophiothrix (Acanthophiothrix) proteus*** Koehler

Fig. 11a, b

*Ophiothrix comata*: Koehler, 1898 : 105, pl. 2, figs. 11–14. [Non *O. comata* Müller & Troschel, 1842.]

*Ophiothrix proteus* Koehler, 1905 : 100–101 ; 1922 : 260–261, pl. 36, figs. 3, 4, pl. 101, fig. 3.
*Placophiothrix proteus* : H. L. Clark, 1939 : 86 ; Balinsky, 1957 : 21.
*Ophiothrix* (*Acanthophiothrix*) *proteus* : A. M. Clark, 1967 : 643, 648.

MATERIAL. NAD 2S, 30°47·1'S : 30°29·1'E (S of Durban), 44 metres ; 1 specimen.

NAD 52B and 55B, 29°29'S : 31°45'E (near Tugela River mouth), 86 metres ; 3 specimens ['Anton Bruun' st. 391B, C].

NAD 58A, 29°26'S : 31°46'E, 77 metres ; 3 specimens [St. 391F].

NAD 63Q, 29°21·6'S : 31°35·7'E, 57 metres ; 5 specimens [St. 391J].

PED 19H, 25°07'S : 34°34'E (between Delagoa Bay and Inhambane, Mozambique), 112 metres ; 1 specimen [St. 372L].

AFFINITIES. Although similar to *Ophiothrix aristulata* in the bare radial shields, long tapering arm spines, slender disc spines and light mid-line to the arms dorsally, these specimens have the pair of dark lines on the arms much better defined, the light mid-line between them being raised on a sharp continuous crest while the plates are broadly truncated at the distal end. In fact the largest specimens seen, d.d. 15–17 mm, have the dorsal arm plates broader than long, length : breadth 1 : c. 1·7, contrary to my diagnosis of the subgenus *Acanthophiothrix*. Nevertheless, their truncated shape allies the species with the other members of the subgenus, few of which reach such a relatively large size.

[See also the discussion under the heading of *Ophiothrix aristulata*.]

### ***Ophiothrix (Ophiothrix) aristulata*** Lyman

Fig. 11c, d

*Ophiothrix aristulata* Lyman, 1879 : 50–51, pl. 15, figs. 421–424 ; 1882 : 223–224, pl. 21, figs. 9–12 ; Koehler, 1904b : 151 ; (?) 1922 : 205–208, pl. 35, figs. 1–3, pl. 97, fig. 1 ; A. M. Clark, 1967 : 640.
*Placophiothrix aristulata* : H. L. Clark, 1939 : 85.

MATERIAL. WCD 218Z, 34°43·3'S : 18°12·5'E (SW of Cape Point), depth ? ; 2 specimens.

AFR 761D, 30°13'S : 15°17·6'E (W of Hondeklip Bay), 260 metres ; 5 specimens [including three in the British Museum collections, no. 1949.9.27.119].

AFFINITIES. In splitting off *Acanthophiothrix* from *Placophiothrix* in 1967, I referred *Ophiothrix aristulata* back to *Ophiothrix* sensu stricto. However, an attempt to key it out from *O.* (*Acanthophiothrix*) *proteus*, collected off Natal and Mozambique revealed its intermediate position, emphasizing the infra-generic rank of *Acanthophiothrix*.

The dorsal armament of the disc, consisting exclusively of more or less rugose spines in the holotype (d.d. 14 mm) and other similarly large specimens, seemed at first sight to provide a reliable distinction of *Ophiothrix aristulata* from *O.* (*Acanthophiothrix*) *proteus* in which trifid stumps normally predominate over fine spinelets and often exist alone. However, the armament of a small paratype of *O. aristulata* from the Agulhas Bank with d.d. 7 mm also has peripheral trifid stumps while conversely several large specimens of *O.* (*Acanthophiothrix*) *proteus* taken off Natal

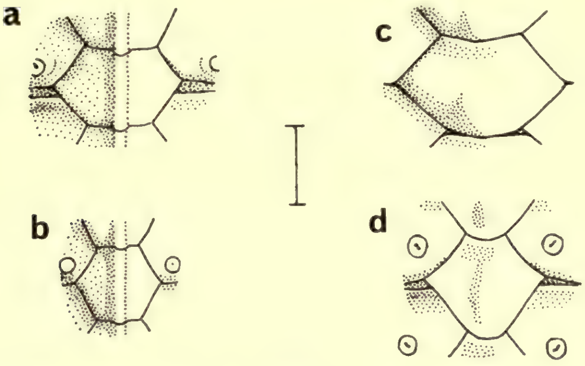

FIG. 11. Dorsal views of proximal arm segments. a and b. *Ophiothrix* (*Acanthophiothrix*) *proteus* Koehler. a. NAD 63Q. D.d. c. 16 mm. b. John Murray Expedition st. MB IIC, Arabian coast, d.d. 9 mm. c and d. *Ophiothrix* (*Ophiothrix*) *aristulata* Lyman. c. AFR 761G. D.d. 16 mm. d. 'Challenger', Agulhas Bank, d.d. c. 10 mm. The scale measures 1 mm.

by the Ecological Survey (d.d. c. 15 mm) all have numerous well-developed spinelets or spines on the centre of the disc, though intermingled with trifid stumps, which again predominate peripherally. Koehler (1922) has also commented on the variation in disc armament of *O. aristulata*, though I think it possible that not all his specimens were conspecific.

The shape of the arm spines appeared also distinct when comparing the John Murray Expedition specimens, which H. L. Clark (1939) referred to these two species, since those he named *Placophiothrix aristulata* have the longer spines on the proximal half of the arms at most four times the segment length with relatively coarse thorns numbering c. 14 each side, whereas those of *proteus* have spines up to six times the segment length with more than 20 fine serrations each side. However, the holotype of *Ophiothrix aristulata* itself has the spines up to 4·6 times the segment length (according to Lyman) and the number of thorns or serrations may also exceed 20.

Two of the specimens from AFR 761 with d.d. c. 16 mm have unusually broad dorsal arm plates, breadth : length nearly 2 : 1, on the more proximal segments and they are contiguous for more than a third of their breadth.

I do not agree with Lyman's statement that the dorsal arm plates have a median ridge giving a carinate appearance. In all the specimens I have studied each plate has a rounded median distal convexity but proximally is flatter medially, in marked contrast to the continuous sharp keel on the arms of *Ophiothrix* (*Acanthophiothrix*) *proteus*. More material from South Africa is needed to show if this character is consistent.

*Ophiothrix aristulata* has an unusually wide geographical range, being also reported from the Philippines to south-east Australia.

### ***Ophiothrix fragilis*** (Abildgaard *in* O. F. Müller)

*Asterias fragilis* Abildgaard *in* O. F. Müller, 1789 : 28, pl. 98.

*Ophiothrix fragilis* : J. Müller & Troschel, 1842 : 110 ; H. L. Clark, 1923 : 337 ; Mortensen, 1933a : 338 ; Madsen, 1971 : 213–214, fig. 36c.
*Ophiothrix triglochis* Müller & Troschel, 1842 : 114 ; Koehler, 1904a : 81–84, figs. 41–45 ; 1908 : 635 ; H. L. Clark, 1923 : 337–339.
*Ophiothrix fragilis* var. *pentaphyllum* : Koehler, 1908 : 635.
*Ophiothrix aristulata* : Döderlein, 1910 : 254, pl. 5, figs. 4, 5. [Non *O. aristulata* Lyman, 1879.]

MATERIAL. Forma *Pentaphylla* : Latitude/longitude squares 26/15, 32/17, 32/18, 33/17, 34/18, 34/21, 33/25, 34/25, 33/27, 32/28, 29/31 ; shore–148 metres.

Forma *triglochis* : 33/17, 33/18, 34/18, 34/21, 33/26, 34/21, 34/22, 34/23, 33/25, 34/25, 33/26, 33/27, 32/28, 30/30, 29/31, 28/32 ; 7–183 metres.

SYNONYMY. The type material of *Ophiothrix triglochis* from Port Natal had the disc armed only with short bifid or, probably more often, trifid stumps, also covering the radial shields, though more sparsely. However, many superficially similar South African specimens actually have the stumps 'multifid', averaging about five points ; alternatively the stumps may be more or less elongated. H. L. Clark (1923) comments 'in typical *triglochis* there are no disc spinelets among the stumps and the radial shields are more or less covered by the latter'. The dorsal arm plates usually have the distal edge simply convex or with a rounded angle, though sometimes with a median distal bump. Such stump-covered South African specimens therefore approximate either to Koehler's form b of *Ophiothrix fragilis* variety *echinata* (1924) armed with trifid or quadrifid stumps only, or to his variety *lusitanica*, with quadri- or quinti-fid stumps. These two northern varieties or forms are both common on the Mediterranean coasts of France, Spain and Portugal, though *lusitanica* also occurs in the Atlantic, as its name suggests. In British waters the common form of *Ophiothrix fragilis* is *pentaphýlla* Pennant, also found in France, with spines as well as stumps on the disc, the radial shields normally relatively large and bare and the dorsal arm plates rhombic with a well-marked distal angle and their surface carinate. However, throughout the European range of *O. fragilis* may be found specimens intermediate in some or all of these characters, for instance with bare radial shields but an armament solely of stumps on the scales or conversely with more or less numerous stumps on the shields but disc spinelets present on the scales. The form and number of the arm spines and the relative arm length also vary.

H. L. Clark (1923) named as *Ophiothrix triglochis* some specimens from False Bay with spinelets among the disc stumps, in one even replacing the stumps and contrasting with bare radial shields. These clearly approximate to some British specimens of *O. fragilis*. Both H. L. Clark and earlier (1908) Koehler identified some specimens of *Ophiothrix* from Saldanha Bay with coarse-spined discs and bare radial shields as *O. fragilis*, Koehler referring them to the variety *pentaphyllum*. However, among the similarly spinose specimens taken by the Ecological Survey are some with the disc spines very stout, mounted on low but distinct tubercles on the scales, as Koehler (1924) described for the Mediterranean *O. quinquemaculata* (Delle Chiaje) in his key to the European species of *Ophiothrix*. Recently, however, Guille (1964) has shown that *O. fragilis* may also encompass *O. quinquemaculata*.

In view of the immense variability of *Ophiothrix fragilis* in the north-east Atlantic, it seems pointless to distinguish *O. triglochis* specifically in the south-east Atlantic.

Although the geographical ranges of the two almost coincide in South Africa it may be useful to retain the name *triglochis* for specimens without disc spines.

### ***Ophiothela nuda*** (H. L. Clark) new comb.

*Ophiopsammium nudum* H. L. Clark, 1923 : 341–342.
*Ophioteresis beauforti* Engel, 1949 : 140–143, figs. 1, 2.
*Ophiothela beauforti* : Balinsky, 1957 : 22–24, pl. 4, fig. 16 ; A. M. Clark & Rowe, 1971 : 117.

MATERIAL. NAD 2T, 30°47·1′S : 30°29·1′E (S of Durban), 44 metres ; 2 specimens.

NAD 15R, 30°47′S : 30°27·5′E, 36 metres ; 4 specimens.

NAD 63Q, 29°21·6′S : 31°35·7′E (near Tugela River mouth), 57 metres : 1 specimen ['Anton Bruun' st. 391J].

PED 10W, 24°46′S : 34°50′E (S of Inhambane, Mozambique), 22 metres ; 8 specimens [St. 372C].

PED 17H, 24°53′S : 34°56′E, 55 metres ; 14 specimens [St. 372G].

MOR 45S, Morrumbene estuary, N of Inhambane (23°S : 35°E) ; 1 specimen.

VARIATION. Two of the four specimens from sample NAD 15 have some coarse, spaced granules towards the periphery of the disc dorsally and on the arms ; the other two are naked except for some peripheral and ventral disc spines. Of PED 10, seven specimens have a continuous coat of coarse granules, one of them with an additional cluster of rough spines in the middle of the disc, but the eighth specimen is almost completely bare on both disc and arms. About half of the 14 specimens of PED 17 have a few median disc spinelets but only one has granules on the arms, mainly sited over the vertebrae. MOR 45 has the disc mainly bare above but many coarse granules near the periphery, which graduate into rugose spines. The arms are covered with a continuous coat of coarse granules for the proximal half but become naked distally.

NOMENCLATURE. The type locality of *Ophiopsammium nudum* is near the Tongaat River mouth, Natal, while that of *Ophioteresis beauforti* is further north in Mozambique. The holotype of *O. nudum* has some inconspicuous disc and arm granules dorsally, despite its specific name. In view of the notes above and previous comments by Balinsky and by me on the variability of *O. beauforti*, clearly this nominal species and *O. nudum* cannot be specifically distinguished. The type-species of *Ophiopsammium*, *O. semperi* Lyman, has a continuous coat of extremely fine granules all over and I am convinced that *O. nudum* is much more closely related to *Ophiothela mirabilis* (Verrill), the type-species, and other members of the genus *Ophiothela* with their relatively coarse granulation, varying in both density and size.

A young specimen from NAD 15 with d.d. only 2 mm shows that this species, like several other ophiotrichids, goes through an *Ophiopteron*-stage with the arm spines webbed.

### *Ophiothela danae* Verrill

*Ophiothela danae* Verrill, 1869 : 391 ; Koehler, 1922 : 297–298, pl. 59, figs. 1–3, pl. 103, fig. 1 ; Mortensen, 1933a : 342 ; A. M. Clark *in* Clark & Rowe, 1971 : 116, pl. 14, fig. 5.
? *Ophiothela dividua* von Martens, 1879 : 127–130, figs. 1–4 ; Balinsky, 1957 : 22.

MATERIAL. NAD 15Q, 30°47′S : 30°27·5′E (S of Durban), 36 metres ; 2 specimens.
JAN 27, Jangamo Reef, Mozambique (c. 24°S : 35°E) ; 5 specimens.

SYNONYMY. In 1933 Mortensen could only put forward the colour pattern of the type material of *Ophiothela dividua*, usually with two dark blue bands across each pair of radial shields, to try and distinguish between it and the similarly fissiparous *O. danae*. In 1971 I noted that the two will probably prove to be synonymous. Unfortunately only three of the present seven specimens have any colour left. One from Jangamo Reef has traces of blue bands across the arms, each about one segment wide and separated by three to five pale segments. Of the two specimens from Natal, one has some large dull red patches, not bands, and the other has fine linear blue-black markings running parallel to the edges of the radial shields (i.e. more longitudinal than transverse) and defining the distal edges of the dorsal arm plates. Koehler (1922, pl. 59, fig. 3) shows a specimen of *O. danae* with slightly coarser dark lines across the arms and irregularly on the disc with one pair of radial shields marked with a transverse band near their distal ends but the others mostly with longitudinal bands on or near the shields. Koehler gives the general colour as pinkish grey 'with dark blue striae on the dorsal surface of the disc and on the arms'. Clearly there is considerable variation in the precise pattern.

Nor is there a reliable zoogeographical distinction. Von Martens said that the type material of *Ophiothela dividua* came allegedly (angeblich) from Algoa Bay, on the south coast of South Africa. However, since the specimens were evidently epizoic on the tropical Indo-Pacific gorgonian *Melitaea ochracea*, of which Natal would be expected to be the southern limit, I suspect that they may have been rather from Delagoa Bay at the southern end of Mozambique. Balinsky has recorded a single specimen from Inhaca, Delagoa Bay, as *O. dividua* since its colour pattern matched that of the types. Mortensen's specimens of *O. danae* were from the vicinity of Durban like the southernmost of the Survey's specimens.

## Family **OPHIOCOMIDAE**

### *Ophiopsila seminuda* A. M. Clark

Fig. 12

*Ophiopsila seminuda* A. M. Clark, 1952 : 218–219, fig. 3.

MATERIAL. FAL 428C and 434B, 34°15·2′S : 18°33·2′E (False Bay), 22 metres ; 11 specimens.
FAL 467P, 34°07′S : 18°42′E, depth ? ; 1 specimen.
SST 22Z, 35°06′S : 22°15′E (S of Mossel Bay), 120 metres : 1 specimen.
LIZ 19U, 33°58·5′S : 25°42′E (Port Elizabeth), 27 metres ; 1 specimen.
SCD 272B, 34°23′S : 25°54′E (S of Port Elizabeth), 181 metres ; 1 specimen.

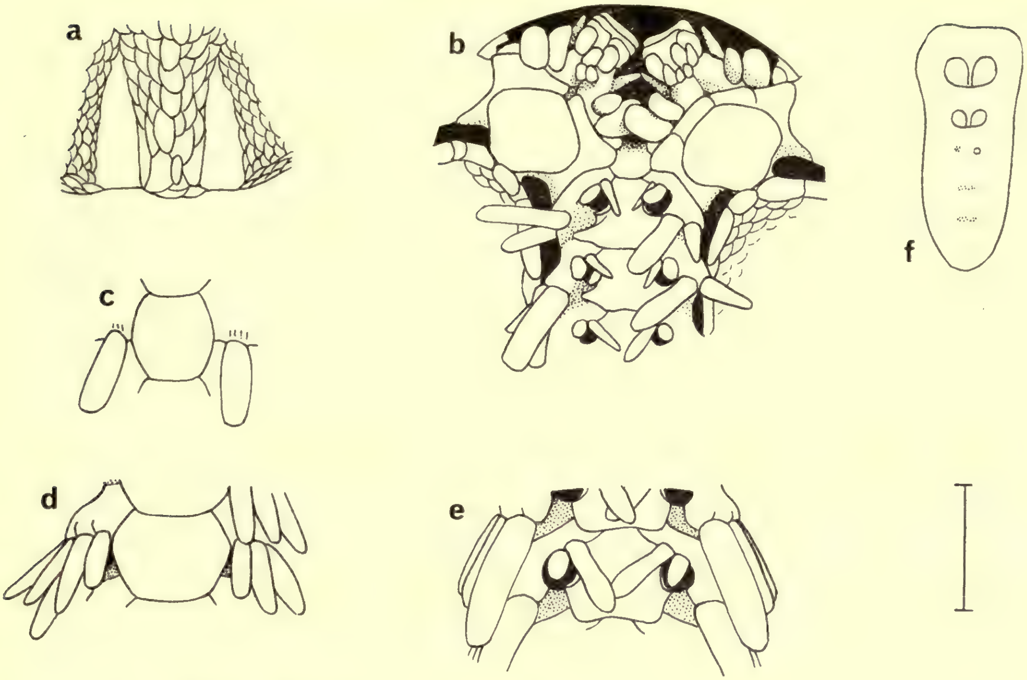

FIG. 12. *Ophiopsila seminuda* A. M. Clark. a–e. SCD 294N. D.d. 9–10 mm. a. Dorsal view of part of disc. b. Two jaws and the first two arm segments. c. Dorsal view of fifth free arm segment. d and e. Dorsal and ventral views of thirty-fifth free arm segment. f. FAL 434B. Isolated dental plate. The scale measures 1 mm for a–e and 0·3 mm for f.

SCD 294N, 33°04′S : 27°57′E (near East London), 84 metres ; 1 specimen.
SCD 326D, 34°27′S : 25°57′E, 172 metres ; 1 specimen.

VARIATION. Although the holotype of *Ophiopsila seminuda* gave the appearance of lacking disc scales ventrally, most of the better-preserved specimens since collected have the under-side of the disc opaque with very fine scales embedded in the rather pustular skin ; only near the genital slits is the scaling barely distinguishable.

In most specimens the radial shields taper proximally, or at least the disc scaling encroaches more on to their surface than in the holotype. They are usually well separated but in the smallest specimen, SST 22, d.d. only 1·8 mm, they approximate distally.

The armament of the jaws also varies, with additional papillae developing in larger specimens. At d.d. 8–10 mm there are usually four to seven tooth papillae at the apex of each jaw superficial to the lowest tooth. The holotype at d.d. 4 mm has only three papillae, the median third one smaller than the other two, which make an almost symmetrical pair on most jaws. The smallest specimen now present, d.d. <2 mm, lacks even the third papilla and looks very amphiurid-like. In addition to the two flat, rounded, distal oral papillae each side observed in the holotype, most of the larger specimens show a much smaller papilla (or scale) distally between the enlarged outer papilla and the ventral arm plate.

The oral shields have a more or less well-developed distal lobe and may even be as long as broad.

The dorsal arm plates broaden somewhat on the stoutest part of the arms beyond the disc and become as broad as long, or broader by about the thirtieth segment, transverse oval in shape.

The arm spines number up to 10 in a specimen with d.d. 8 mm and up to nine at d.d. 7 mm. One with d.d. only 5·5 mm also has nine spines on a few segments, though the smaller holotype has only seven. The spines are all spatulate in shape with broad round tips. The lowest and longest is usually about one-and-a-half times the segment length. The length of the long inner tentacle scale ranges from equal to the segment length in smaller specimens up to twice as long in the largest ones.

AFFINITIES. In spite of the discovery of specimens with more arm spines and ventrally scaled discs, this species still differs from *Ophiopsila aranea* (known from Europe to tropical West Africa) in the fineness of this scaling as well as in the fewer tooth papillae at a comparable size, though clearly the two are fairly closely related.

JAWS. A drawing of a dissociated dental plate is given here since no illustrations of the dental and oral plates of *Ophiopsila* were included by Murakami in his survey of the ophiuroids (1963), though he described those of a new species of the genus which he subsequently named *Ophiopsila squamifera*. Judging from his description, the dental plates of *O. seminuda* are very similar to those of his Japanese species and similar to those of *Ophiocoma* and *Ophiomastix* which he illustrated, though rather smoother.

### ***Ophiopsila bispinosa*** sp. nov.

Fig. 13

MATERIAL. NAD 35X, 29°35′S : 31°38′E (near Tugela River mouth), 150 metres ; 1 broken specimen ['Anton Bruun' st. 390L].

NAD 46C, 29°35′S : 31°42′E, 138 metres ; 1 specimen, the holotype [St. 390S].

NAD 52D, 29°29′S : 31°45′E, 86 metres ; 1 specimen [St. 391C].

NAD 58A, 29°26′S : 31°46′E, 77 metres ; 1 specimen [St. 391F].

DESCRIPTION. The holotype is the least poorly preserved of all the specimens but even it has the disc broken, probably regenerated. The original d.d. was probably c. 9 mm. The arms are broken. The oral frame (from the distal edge of one oral shield to the distal edge of the first ventral arm plate opposite) measures 3·3 mm in diameter. [This compares with an oral frame diameter of 3·5 mm in the specimen of *Ophiopsila seminuda* with d.d. c. 8 mm.] The disc is very poorly calcified, mainly bare or with scales so minute and thin as to be transparent except around the radial shields. The shields have length : distal breadth 1·5 : 0·33 mm.

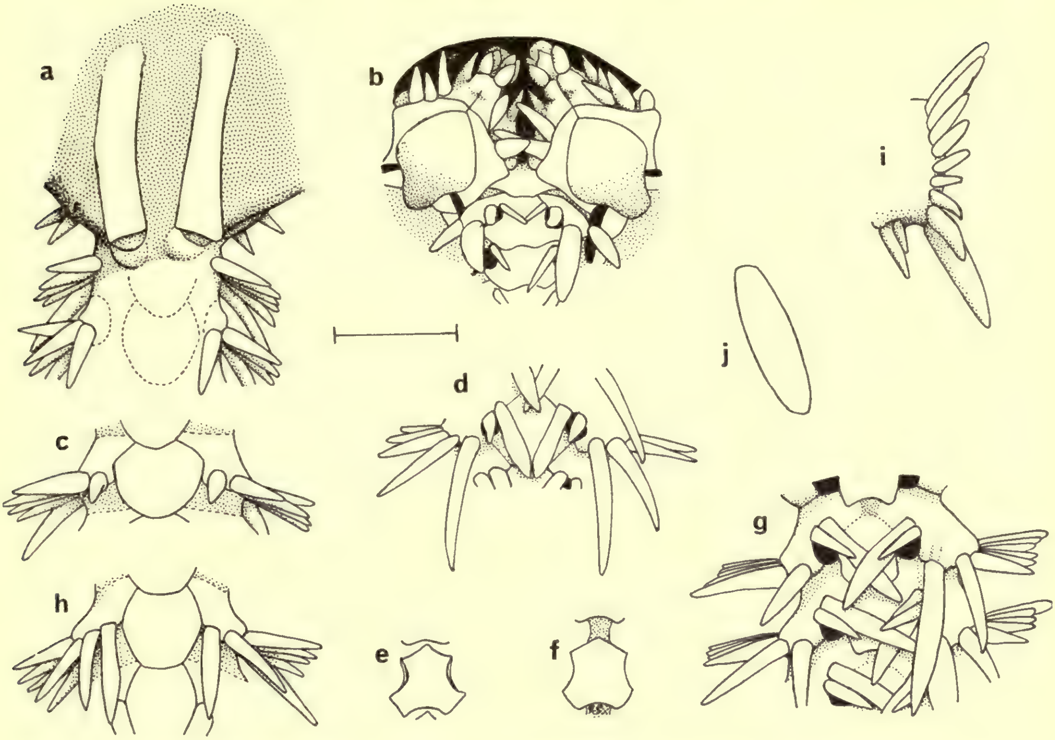

FIG. 13. *Ophiopsila bispinosa* sp. nov. a–f. Holotype. Oral frame diameter 3·3 mm. NAD 46C. a. Dorsal view of part of disc and the base of one arm. b. Two jaws and the first two arm segments. c and d. Dorsal and ventral views of the twelfth free arm segment. e and f. Sixth and twenty-fifth ventral arm plates. g–j. Paratype. NAD 35X. Oral frame diameter 3·5 mm. g–i. Dorsal, ventral and side views of arm at about the twentieth free segment. j. A particularly broad lowermost spine. The scale measures 1 mm.

The oral shields are longer than broad, spearhead-shaped with the proximal angle rounded and the distal lobe narrower. The adorals are contiguous or closely approximating interradially and have a distal lobe between the oral shield and the first lateral arm plate each side. The tooth papillae at the apex number only three to five, two of them forming a symmetrical amphiurid-like, though pointed, pair on four out of the five jaws. The distal oral papillae number two in five positions and three in the other five; all of them are conspicuously spiniform, broad medially, slightly flattened and tapering to a more or less blunted point. The innermost one arises partly or completely from the oral plate but leaves a diastema between it and the tooth papillae, revealing the long spiniform oral tentacle scale within the slit. In addition, on the outer corner of the adorals is a small rounded supernumerary papilla, inset slightly into the oral slit and partly abutting on the first ventral arm plate.

The basal dorsal arm plates are very ill-defined but may be regenerating; they are about as broad as long but by the twelfth free segment have become slightly broader than long and deep fan-shaped with the two proximal sides almost straight; they are widest proximal to the middle of their length and have a slight angle in the middle of the distal curve. They are contiguous for less than half their breadth.

The proximal ventral arm plates are broader than long since each has a prolonged lateral angle distal to the tentacle pore, though this is progressively reduced beyond the basal segments. The middle of the distal edge is distinctly concave. By the middle of the arm the ventral arm plates have become longer than broad and consecutive ones are spaced from each other, exposing a membranous space between the lateral arm plates medially.

The lateral arm plates bear eight spines for about the first 12 free segments, then nine for two or three segments, then ten for about two segments before dropping to nine again. The upper and middle spines are markedly flattened in approximately the vertical plane, presenting their maximum area when looking along the length of the arm, when standing erect. However, the more ventral ones are obliquely flattened and the lowermost, when pointed downwards, is flattened laterally. The lowest is the longest spine, up to 1·3 mm long, compared with a corresponding segment length of 0·7 mm. The second from lowest is also relatively long, then come four or five smaller spines, while the uppermost ones are longer again. The spines are hollow centrally but the cavity is narrow, owing to the considerable flattening.

The inner tentacle scale is sword-like and may exceed 0·8 mm in length. As preserved, it normally crosses its partner over the distal end of the ventral arm plate. The outer tentacle scale is also flattened and spiniform but only about half as long.

Paratypes. The larger of the three paratypes (sample NAD 35) (fig. 13g–j) has only a remnant of the disc attached to the oral frame, which measures 3·5 mm in diameter. The distal oral papillae usually number three each side and all are pointed and slightly flattened; the outer one (or two) may be slightly broadened medially but markedly tapering in the distal third. The arm spines appear less markedly flattened than in the holotype, very slender and tapering; the uppermost are almost as markedly elongated as the lowermost.

The two other paratypes both have the oral frame 2·2 mm in diameter and are remarkable in having six arms; because of this the jaws are unusually narrow with only two to four tooth papillae and the oral shields are even longer than in the holotype. One has some quite large but extremely thin disc scales dorsally. Their arm spines number up to eight.

Affinities. *Ophiopsila bispinosa* resembles *O. seminuda* in the relatively small number of tooth papillae but carries the reduction of the disc scaling even further. It is most easily distinguished by the spiniform distal oral papillae and the more pointed arm spines, also the spiniform second tentacle scale. There may also be a geographical distinction, the new species being found so far only in Natal whereas *O. seminuda* has not been recorded from north-east of East London. The other neighbouring species is *Ophiopsila paucispina* Koehler, from northern Mozambique, which differs not only in the few arm spines (only four at d.d. 11 mm – actually five according to Koehler in 1930) but also in the oral shields being broader than long, the tooth papillae forming a cluster of four rows and the distal oral papillae being rounded. Morphologically, the closest species of *Ophiopsila* is probably *O. timida* Koehler (1930) from the East Indies. This also appears to have tenuous disc scaling, spiniform distal oral papillae (but only two in each series), the outer tentacle scale also spiniform and a similar number of arm spines, eight at d.d. 5 mm. However, in *O. timida* the spines are cylindrical with rugose blunt tips, the oral shields are as much as two-and-a-half times as long as broad and there is a large cluster of tooth papillae with usually four superficial ones, even at a smaller size.

Remarkably reminiscent of *Ophiopsila bispinosa*, at least in the shape of the arm spines and the bar-like separated radial shields, is *Amphiura linearis* Mortensen, also from Natal, which is unusual for an *Amphiura* just because of the separated shields. The types were in poor condition, even the larger with d.d. only 3·5 mm. However, the disc is evidently covered with fine scales and the distal oral papillae and the tentacle scales, though pointed, are single.

## Family **OPHIURIDAE**

### ***Ophiura trimeni*** Bell

*Ophiura trimeni* Bell, 1905b : 257, pl. 1, figs. 3, 4 ; H. L. Clark, 1923 : 360–361 ; Mortensen, 1933a : 384–385, fig. 84.

*Gymnophiura novembris* Hertz, 1927 : 72–73, pl. 6, figs. 9, 10 ; Mortensen, 1933a : 393–394, fig. 89.

Material. AFR 830A, 35°11′S : 18°42′E (S of False Bay), 315 metres ; 1 poor specimen.

WCD 76D, 34°17′S : 17°53′E (W of Cape Point), 320 metres ; 5 specimens.

WCD 105C, 33°07′S : 17°33′E (W of Saldanha Bay), 183 metres ; 8 poorly preserved specimens.

TRA 51A, West of Dassen Island (33°S : 17°E), 356 metres ; 1 specimen.

TRA 73G, 32°06′S : 16°37′E (W of Lambert's Bay), 310 metres ; 4½ poor specimens.

LBT 27L, 68C and 72F, off Lambert's Bay (32°S : 16–17°E), 280–400 metres ; 1 poor specimen and 7 small ones.

Synonymy. The type and only recorded locality of *Gymnophiura novembris* is 35°09′S : 18°32′E, on the Agulhas Bank very close to sample AFR 830A, in 564 metres. The largest syntype has d.d. only 5 mm. Mortensen figured one of the syntypes, showing the same unusual membranous areas bordering the first two dorsal arm plates laterally that occur in specimens which have arm combs present and thus run down to *Ophiura trimeni*. He pointed out the great similarity between the two. In fact, the arm combs were overlooked by Bell in the type of *O. trimeni* and they are certainly difficult to see or absent in smaller specimens, observation not being helped by the poor condition shown by most preserved individuals of this species. H. L. Clark identified as *O. trimeni* specimens from both south-east and north-west of the type locality of *G. novembris*. Clearly the two nominal species are sympatric and I cannot see any way in which *G. novembris* can be distinguished. It is accordingly now referred to the synonymy of *O. trimeni*.

### ***Amphiophiura trifolium*** Hertz

*Amphiophiura trifolium* Hertz, 1927 : 78–79, fig. 3, pl. 6, figs. 14, 15 ; H. L. Clark, 1939 : 108–109.

MATERIAL. ABD 7C, 24°12′S : 36°01′E (SE of Inhambane, Mozambique), 1140 metres ; 4 specimens ['Anton Bruun' st. 369J].

ABD 10B, 27°09′S : 34°09′E (E of Natal–Mozambique border), 1335 metres ; 3 specimens [St. 374D].

RANGE. These two records extend the known range of the species southwards from off Mombasa and Somalia in East Africa ; it has also been recorded from the Maldive area. The minimum depth known is also extended to 1140 metres, other depths ranging from 1289 to 2727 metres.

### ***Ophiomisidium pulchellum*** (Wyville Thomson)

*Ophiomusium pulchellum* Wyville Thomson, 1877 : 67–69, figs. 18, 19 ; Lyman, 1882 : 96–98, pl. 3, figs. 1–3.
*Ophiomisidium pulchellum* Koehler, 1914 : 37 ; H. L. Clark, 1923 : 356–357.

MATERIAL. SST 12J, 35°22′S : 22°31′E (S of Mossel Bay), 200 metres ; 6 specimens.

The size ranges from 2·5 mm to 4·1 mm d.d. The smallest specimen has only three pairs of tentacle pores and only the largest has appreciable knobs in the middle of each primary disc plate. The holotype has d.d. 4·5 mm and is the largest recorded.

## Family **OPHIOLEUCIDAE**

### ***Ophiocirce inutilis*** Koehler

Fig. 14

*Ophiocirce inutilis* Koehler, 1904b ; 13–14, pl. 3, figs. 4, 5 ; 1922 : 436 ; H. L. Clark, 1939 : 131–132.

MATERIAL. PED 2J, 24°46′S : 35°20′E (S of Inhambane, Mozambique) ; 132 metres ; 5 specimens ['Anton Bruun' st. 371E].

RANGE. This record provides an extension of range southwards from the Zanzibar area.

The specimens agree with Koehler's description except that the better preserved ones have only a small indentation in the disc opposite each arm.

Since Koehler's figures are very diagrammatic, fresh drawings are given here.

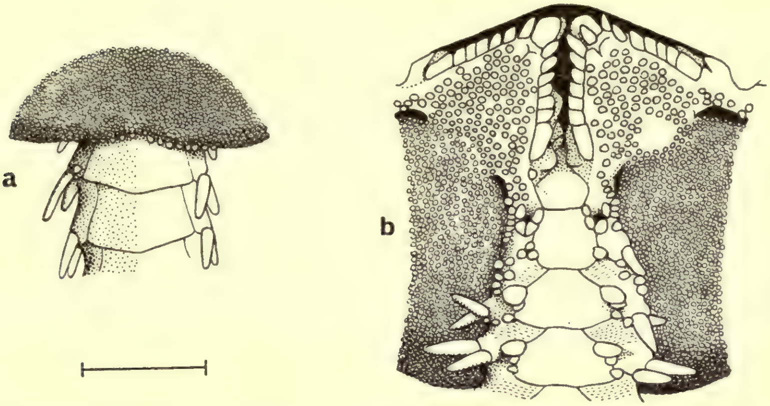

FIG. 14. *Ophiocirce inutilis* Koehler. PED 2J. D.d. 6·2 mm. a. Dorsal view of part of disc and the base of one arm. b. Two jaws and the base of one arm with adjacent interradii; the fingerprint-like texture of the lateral arm plates indicated by dashes. The scale measures 1 mm.

## ***Ophiopallas paradoxa*** Koehler

### Fig. 15

*Ophiopallas paradoxa* Koehler, 1904b : 12–13, pl. 3, figs. 1–3; 1922 : 436–437, pl. 79, figs. 1, 2.
*Ophiopallas paradoxa altera* Hertz, 1927 : 110, pl. 9, fig. 5.

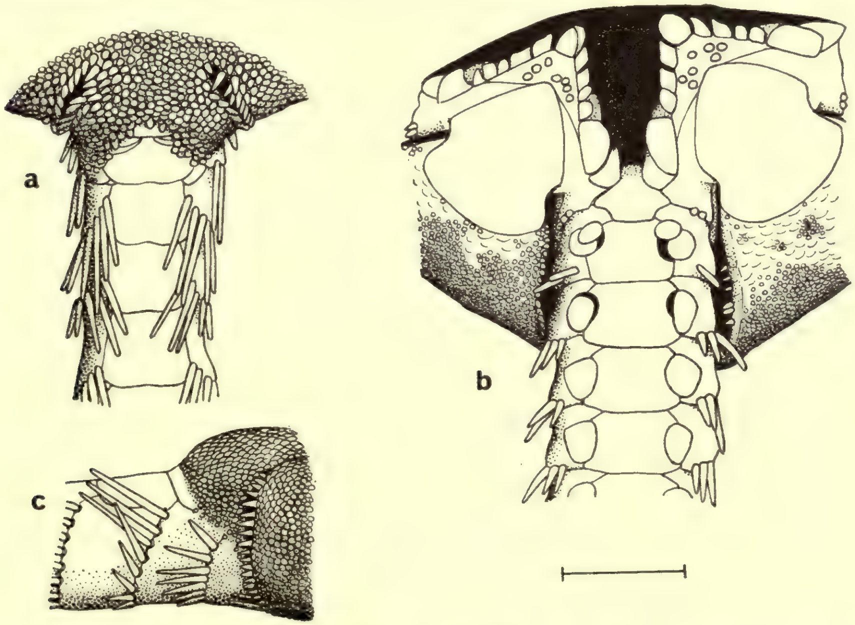

FIG. 15. *Ophiopallas paradoxa* Koehler. 'Albatross' st. 5541, Philippine Is., 400 m. U.S.N.M. no. 41347. D.d. 6 mm. a. Dorsal view of part of disc and the base of one arm. b. Two jaws and the base of an arm with adjacent interradii (some of the granules probably rubbed off). c. Side view of base of an arm. The scale measures 1 mm.

MATERIAL. ABD 8R, 24°40′S : 35°28′E (S of Inhambane, Mozambique), 347 metres ; 1 specimen ['Anton Bruun' st. 370G].

RANGE. This record provides an extension of the range to Mozambique. Unfortunately the specimen is not in good condition and does not help to settle whether Hertz' subspecies *altera* from off Dar-es-Salaam is valid or distinguished only by immature characters. Her type has d.d. only 4 mm whereas in the holotype of *Ophiopallas paradoxa* it is 8 mm. This may well account for the smaller number of oral papillae and the relatively narrower dorsal arm plates.

The figure given here is of a specimen from the Philippines, named by Koehler, which is in better condition than the present one.

## INCERTAE SEDIS

### ***Anamphiura valida*** H. L. Clark

Fig. 16

*Anamphiura valida* H. L. Clark, 1939 : 70–72, figs. 26A, 27.

MATERIAL. ABD 15D, 29°42′S : 31°38′E (near Tugela River mouth), 350 metres ; 2 specimens ['Anton Bruun' st. 390E].

DESCRIPTION. This peculiar species is known only from H. L. Clark's description of the holotype, d.d. 5 mm, and I think a supplementary account of the present material is worth while.

The larger of the two specimens has d.d. 3·6 mm and arm length c. 9 mm. The primary rosette is perfectly regular, as in the three paratypes. The radial shields are slightly convex, joined for just over half their lengths but cut away in the distal third with a slight concave adradial edge to make a notch above the base of the arm in which the very narrow swollen first dorsal arm plate appears below. At least one pair of radial shields is distinctly asymmetrical with one shield larger than the other. The distal ends of the genital plates projecting beyond the radial shields each bear two conical spinelets, much shorter than the scattered disc spinelets and resembling an ophiurid arm comb. H. L. Clark's figure shows only one such spinelet on each plate in the holotype. The jaw structure is variable with two to four small tapering apical papillae, not one jaw showing the symmetrical pair of infradental papillae characteristic of the family Amphiuridae, to which H. L. Clark referred *Anamphiura*. The abradial flanges of the oral plates each side are more nearly superficial than in most amphiurids with the free proximal end of the oral tentacle scale level with the apical papilla on one jaw and only slightly inset on the others. The distal papillae number only two, the outer one wider, and are quite separate. H. L. Clark found three in the holotype and his figure shows them incorrectly as a single tri-lobed unit ; though clustered together they are not fused. The teeth are rounded or slightly squared off but relatively narrower than is usual in amphiurids. The ventral arm plates are quite unlike the usual amphiurid shape, having a prolonged lateral angle each side distal to the tentacle pore meeting the lateral plate so as to encircle the

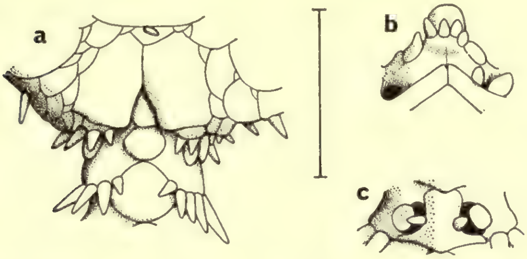

FIG. 16. *Anamphiura valida* H. L. Clark. ABD 15D. D.d. 3·6 mm. a. Dorsal view of part of disc and the base of one arm. b. One jaw, the distal oral papillae missing on the left side. c. Ventral view of third arm segment. The scale measures 1 mm.

pore. The alignment of the two tentacle scales found on the first five or six segments is also unlike that of any amphiurid, the smaller scale arising on the edge of the ventral arm plate from about midway along its length, *not* at the proximal end, while the larger rounded scale is hinged almost opposite to it on the lateral plate. The three upper spines of the five on the first and second arm segments are markedly flattened and expanded ; those of the first segment at least make a continuous flange on the adradial side of the genital slit. The entire surface has a distinctly granular texture.

AFFINITIES. The relatively huge primary rosette, presence of arm combs of a kind, apical jaw structure and form of the ventral arm plates and tentacle pores, all seem to me very unamphiurid-like but show affinities in some ways with the Ophiuridae, in others with the Ophiactidae. However, the notch between the distal ends of the radial shields, the spines on the genital plates distal to the radial shields, the flattened arm spines opposite the genital slits, the irregular papillae at the apex of the jaw, the shape of the ventral arm plates with latero-distal angles meeting the lateral plates distal to the pore and the position of the tentacle scale on the ventral plate (relatively short through the scale is) all agree with the anomalous genus *Amphilimna*, recently referred from the Amphiuridae to the Ophiacanthidae by Thomas (1967). Hopefully, the main 'Anton Bruun' collections include further material of this sample for anatomical study to help decide the best systematic position for this genus.

RANGE. This record extends the known range of the species south from the Zanzibar area.

## Class *ECHINOIDEA*

### Family **ECHINIDAE**

### ***Dermechinus horridus*** (A. Agassiz)

*Echinus horridus* A. Agassiz, 1879 : 203 ; Döderlein, 1906 : 220, pl. 28, figs. 1, 2, pl. 35, figs. 2, 3, pl. 47, figs. 10, 11.

*Dermechinus horridus* : Mortensen, 1943 : 112–117, figs. 46–49, 50a, pl. 19, figs. 6–10, pl. 20, figs. 1–3, pl. 56, figs. 22, 23, 29–31.

Material. WCD 219F, 34°42·8′S : 18°08·8′E (SW of Cape Point), depth ? ; 1 specimen.

This individual is unusual in having the peristome larger than the apical system by 4·5/4·0 mm. However, it has horizontal diameter only 15 mm, whereas Mortensen's smallest specimen measured has h.d. 39 mm. The test is coloured vermilion and white, the very edges of the apical system opposite the interambulacrals are densely red and also the median parts of the interambulacrals but the ambulacrals and adjacent parts of the interambulacrals are white. All the spines are vermilion. The pores and tube feet are very small. Pedicellariae appear rare but possibly many have been lost. A globiferous one has two teeth each side and a tridentate has spoon-shaped valves but constricted necks.

## Family **BRISSIDAE**

### ***Spatagobrissus mirabilis*** H. L. Clark

*Spatagobrissus mirabilis* H. L. Clark, 1923 : 402–404, pl. 23 ; Mortensen, 1951 : 492–494, figs. 258–260, pl. 28, figs. 10–12, pl. 60, fig. 8.

Material. FB 1067, 34°09·5′S : 18°24·25′E (False Bay), 26·5 metres ; 1 specimen. Length : breadth is 28/23 mm = 1·22 : 1. Height 15 mm.

The peripetalous fasciole is almost oval but well separated from the posterior end by 6–7 mm. It is more like the holotype than the specimen figured by Mortensen, which was rounder. The genital pores are undeveloped, as in the specimen of similar size in the British Museum collection. The test is broken in the subanal area.

The holotype has test length 112 mm and length : breadth 1.18 : 1.

## APPENDICES

[Specimens from outside southern Africa]

### I. Vema Sea-mount (see Berrisford, 1969)

This is in approximately 32°S : 8°E, c. 450 miles W of Lambert's Bay ; 54–61 metres.

*Comanthus wahlbergi* (J. Müller)

VEM 3F, 6A, 10A and 19W ; 19 specimens.

*Ophionereis porrecta* Lyman

VEM 15V ; 1 specimen. The middle arm spines are unusually enlarged at about a third of the length from the disc.

*Ophionereis* sp. indet.

VEM 15T ; 1 specimen, small and in poor condition. This might be *O. dubia* but the probability of both species having reached the sea-mount from Africa is small.

*Ophiarachnella capensis* Bell

VEM 3E, 15U ; 3 specimens. These have d.d. 19, 17 and 4 mm whereas in the largest mainland specimen recorded (H. L. Clark, 1923) it is 15 mm and the largest Survey specimen has d.d. 13 mm. The two largest Vema specimens have up to seven arm spines, equal in length to about half the segment length, except the longer lowest one; the middle ones are less conical than in mainland specimens. Also the supplementary oral shields are relatively larger, one or two of them almost equal in area to the main shield, the two together forming a continuous oval in the largest specimen, which also shows a pair of pores between the first and second ventral arm plates not seen in the 17 mm specimen. I think that these small differences are accountable to the greater size; certainly the trend towards relatively larger supplementary oral shields is shown in mainland specimens with d.d. c. 13 mm.

## II. WALTER'S SHOAL

This is in approximately 33°S : 44°E, S of Madagascar and c. 1000 miles E of East London; 38–46 metres.

*Comanthus wahlbergi tenuibrachia* A. M. Clark
WSS 1U; 7 specimens. ['Anton Bruun' st. 381A–C. See A. M. Clark, 1972 : 78–81.]

*Ophiocoma* sp. aff. *O. pica* Müller & Troschel
WSS 1V; 1 specimen.

## III. MADAGASCAR

*Amphioplus* (*Lymanella*) *hastatus* (Ljungman)
MDD 1B, 23°19′S : 43°36′E (near Tulear), 82 metres; 1 complete and 2 discless specimens ['Anton Bruun' st. 363W].

*Amphioplus* sp. C
MDD 2C, 23°20′S : 43°36′E (near Tulear), depth ?; 1 complete specimen, 1 with disc detached and 1 with disc missing.

D.d. of the intact specimen is 5·0 mm. It is covered with fine smooth scales except that the uppermost ventral scales have their edges prolonged into spinose projections, as in *Amphioplus* (*Lymanella*) *furcatus* and *Amphiodia* (*Amphispina*) *microplax*. In addition, there is a triple spinose projection distal to each radial shield as in *Amphioplus pectinatus*, to which it has a considerable resemblance. The radial shields are narrow, c. 1·0 mm long and are contiguous for about the distal third, separated proximally by a wedge of scales. The primary plates are just distinguishable, though widely spaced among the disc scales.

The oral shields are elongated rhombic, widest in the middle, with the proximal and distal lobes both broadly rounded. The adoral shields meet interradially. The oral plates are rather short. The four rounded oral papillae are distinctly arranged in a straight line, as in the subgenus *Lymanella*, rather than the concave row of most species of *Amphioplus* sensu stricto. There is a very small gap between the infradental and second papillae, through which the small oral tentacle scale can be seen. Also the third and fourth oral papillae tend to gape around the second oral tentacle. The fourth papilla is based at least partly on the first ventral arm plate. The oral formula is $\mathrm{m,m\overline{n,n}\ \overline{n,n}+t}$.

The dorsal arm plates are fan-shaped, broadest distally, the rounded distal edge sometimes with a slight median angle; they are mostly not quite contiguous. The proximal ventral arm plates are almost square but the shape becomes more pentagonal with the proximal lobe prolonged. The sides are almost parallel, slightly excavated for the pores and the distal edge is straight or slightly concave. The proximal lateral arm plates carry four slender pointed spines, giving way distally to three. There are two relatively small tentacle scales, the inner one extending less than half the length of the side edge of the ventral arm plate.

The detached disc is similar to that of the intact specimen, with the radial shields distally contiguous and spinose processes present along the disc margin and outside the radial shields. The oral frames show minor differences in the shapes of the oral shields but again the alignment of the oral papillae in a straight line is noticeable. The combination of these two characters probably justifies the distinction of a new species. Since it is likely that there is more abundant and better preserved material with the balance of the 'Anton Bruun' collections, I do not think it desirable to name it in the present context.

## IV. South-West Indian Ocean Submarine Ridge

A single dredging station on about the highest point of the ridge at 36°48′S : 52°08′E (about mid-way between Port Elizabeth and Amsterdam Island, or north of the Crozet Islands), 400 metres.

| | |
|---|---|
| *Crotalometra magnicirra* (Bell) | 5 specimens |
| *Glyptometra sclateri* (Bell) | 4 specimens |
| Juvenile indeterminable Antedonidae | 3 specimens |
| *Democrinus chuni* (Döderlein) | 1 specimen |
| *Porphyrocrinus polyarthra* A. M. Clark.<br>[See A. M. Clark, 1973.] | 2 specimens |
| *Odinia clarki* Koehler<br>Otherwise known from the Maldive area. | 5 broken specimens |
| *Ophiomyxa vivipara capensis* Mortensen | 4 specimens |
| *Ophiomitrella corynephora* H. L. Clark | 3 specimens |
| *Ophiomitrella* sp. | 1 specimen |

Like the three *O. corynephora*, this was clinging to a gorgonian. It differs from them in the much shorter disc armament, the stumps barely longer than broad. The arm spines do not exceed the segment in length, as in *O. hamata*, from which it differs in the spines not being distinctly rugose and again probably in the shorter disc spines. Unfortunately the size is small, d.d. only 4·5 mm.

| | |
|---|---|
| Juvenile indeterminable Ophiacanthidae | 3 specimens |
| *Ophiomusium* sp. | 5 specimens |

All these specific identifications provide extensions of range to this remote part of the southern Indian Ocean, except for the stalked crinoid *Porphyrocrinus polyarthra* of which this is the first record.

The fact that five of the six other species are common to South Africa, having spanned the enormous gulf between, is of particular interest, though of course larval transport from South Africa must be facilitated by the eastwards flowing current.

## SUMMARY OF TAXONOMIC CHANGES

### NEW SPECIES

*Amphilimna cribriformis* (Ophiuroidea) Family Ophiacanthidae
*Ophionephthys lowelli* (Ophiuroidea) Family Amphiuridae
*Ophiopsila bispinosa* (Ophiuroidea) Family Ophiocomidae

### OTHER TAXONOMIC CHANGES

*Astropecten phragmorus* Fisher – reduced to a subspecies of *A. polyacanthus* Müller & Troschel.

*Ceramaster chondriscus* H. L. Clark, 1923 – referred to synonymy of *C. patagonicus euryplax* H. L. Clark, 1923.

*Hacelia superba* var. *capensis* Mortensen – raised to specific rank.

*Asterina dyscrita* H. L. Clark – referred to *Patiriella.*

*Echinaster reticulatus* H. L. Clark – referred to *Henricia.*

*Perissasterias obtusispina* H. L. Clark, 1926 – probably a synonym of *P. polyacantha* H. L. Clark, 1923.

*Amphiura adjecta* and *A. compressa* Mortensen, 1933 – referred to synonymy of *A. capensis* Ljungman, 1867.

*Amphiura kalki* Balinsky, 1957 – referred to synonymy of *A. candida* Ljungman, 1867.

*Amphioplus* (*Lymanella*) *furcatus* Mortensen – restored from the synonymy of *A. hastatus.*

*Ophiothrix triglochis* Müller & Troschel – reduced to a form of *O. fragilis* (Abildgaard).

*Ophiopsammium nudum* H. L. Clark, 1923 – referred to *Ophiothela* and with synonym *Ophiothela* (formerly *Ophioteresis*) *beauforti* (Engel, 1949).

*Gymnophiura novembris* Hertz, 1927 – referred to synonymy of *Ophiura trimeni* Bell, 1905.

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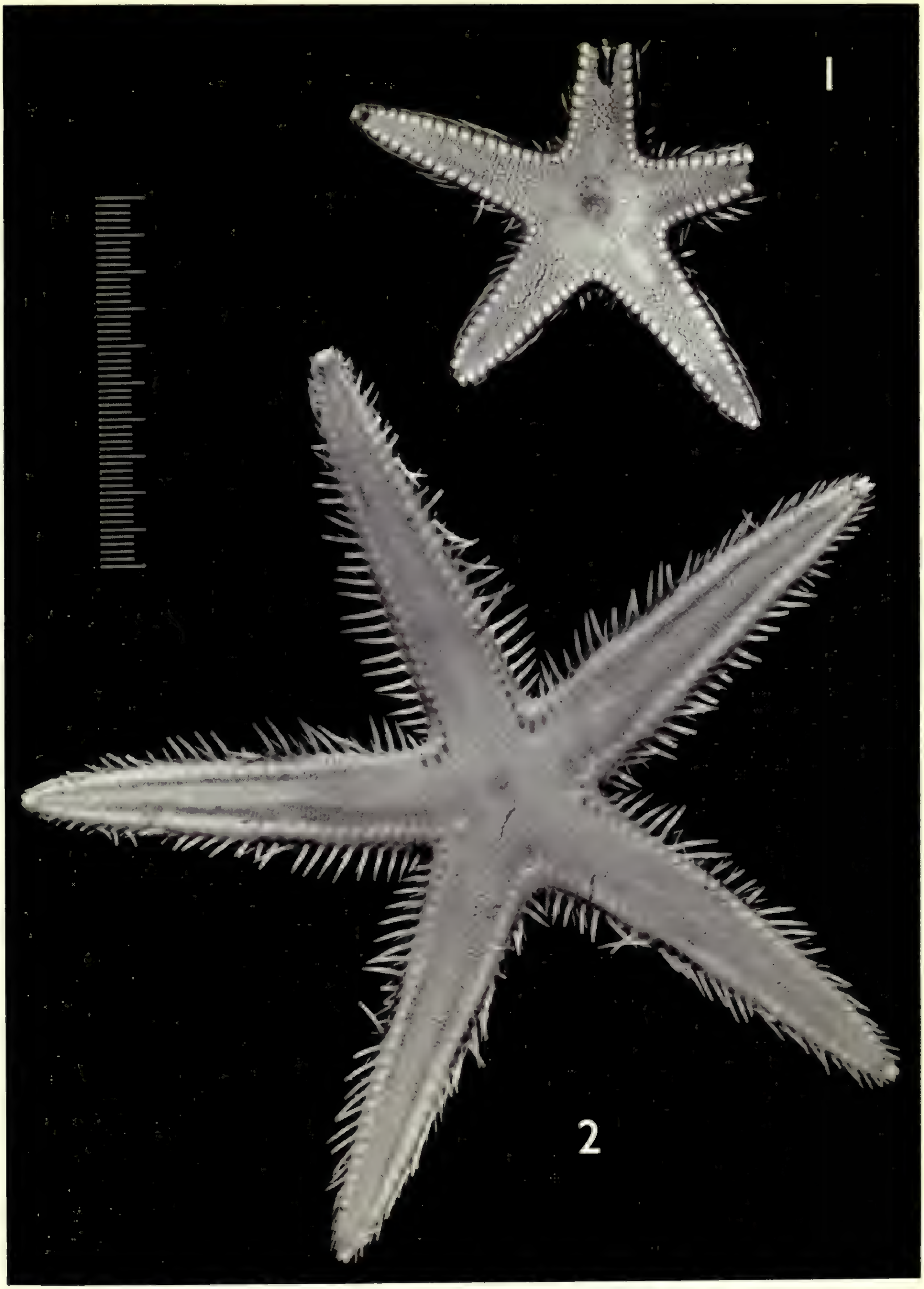
## PLATE 1

FIG. 1. *Astropecten granulatus natalensis* John. Lectotype. B.M. reg. no. 1904.4.20.120.
FIG. 2. *A. polyacanthus phragmorus* Fisher. 1904.4.26.9. R 70 mm. [The locality of both specimens is assumed to be Natal.]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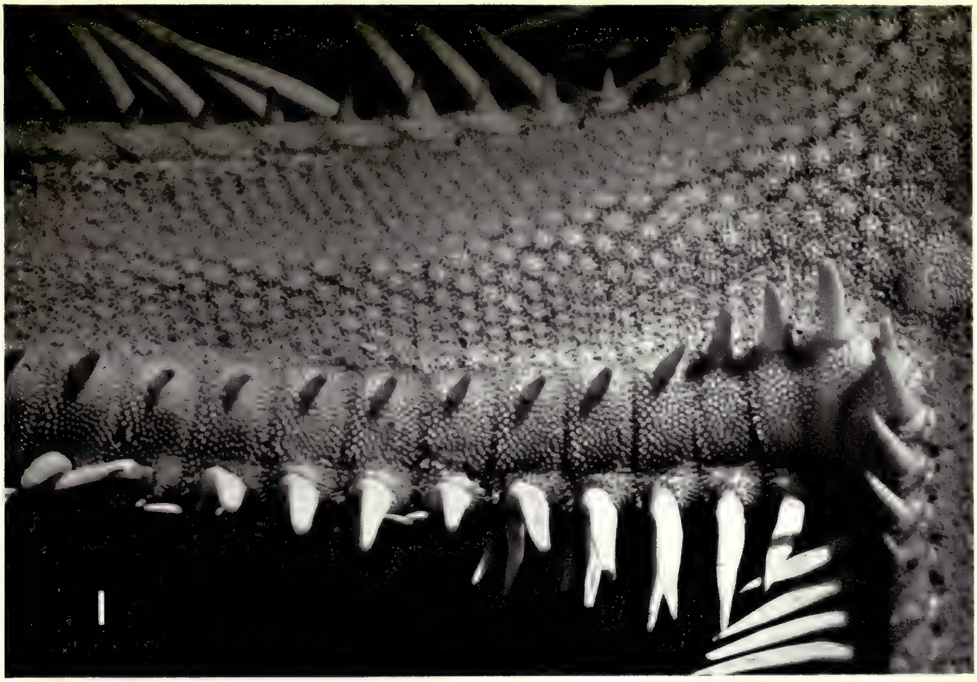
## PLATE 2

FIG. 1. *Astropecten polyacanthus phragmorus* Fisher. 1904.4.26.9. Enlargement (× 5) of proximal part of arm viewed obliquely, showing continuous series of superomarginal spines.

FIG. 2. *A. polyacanthus polyacanthus* Müller & Troschel. B.M. reg. no. 1972.8.22.32, Assab, Eritrea. R 105 mm. Similar view (× 2) showing the proximal gap in the spine series. (This specimen has an unusually large number of supernumerary superomarginal spines.) [Photographed by Patricia Cunningham, the remainder by Mr P. A. Richens of the British Museum Photographic Studio.]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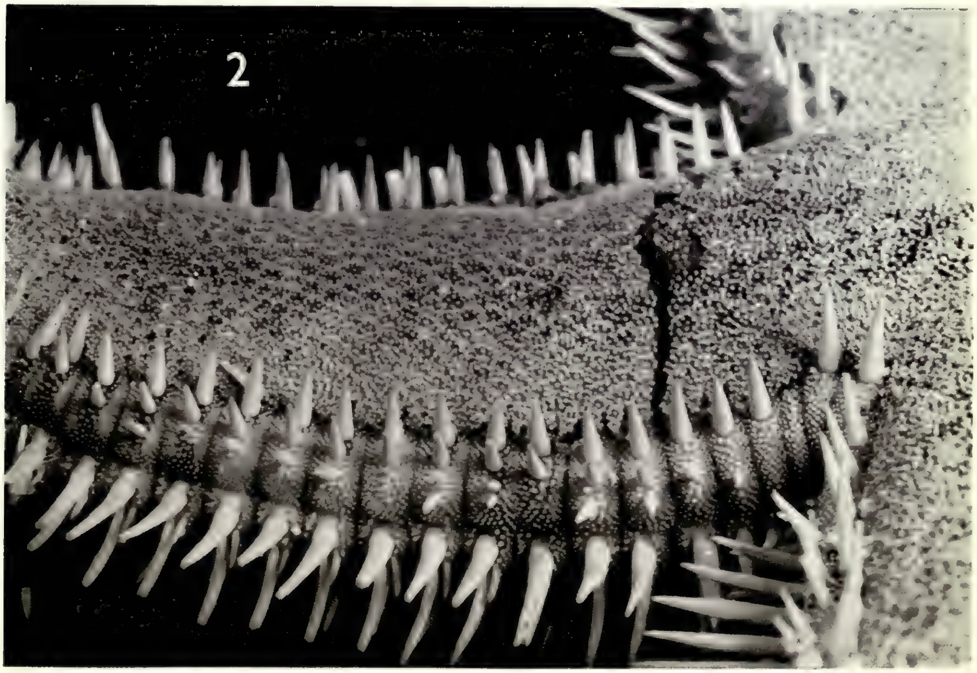
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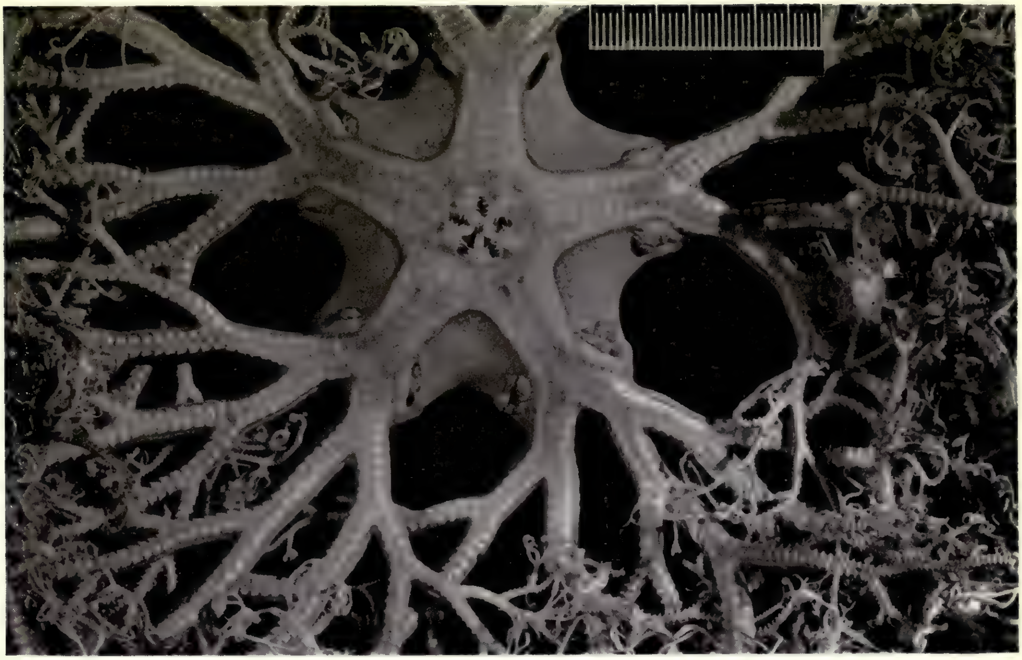
PLATE 3

FIGS. 1 and 2. *Astrocladus euryale* (Retzius). SCD 155P. Ventral and dorsal views.



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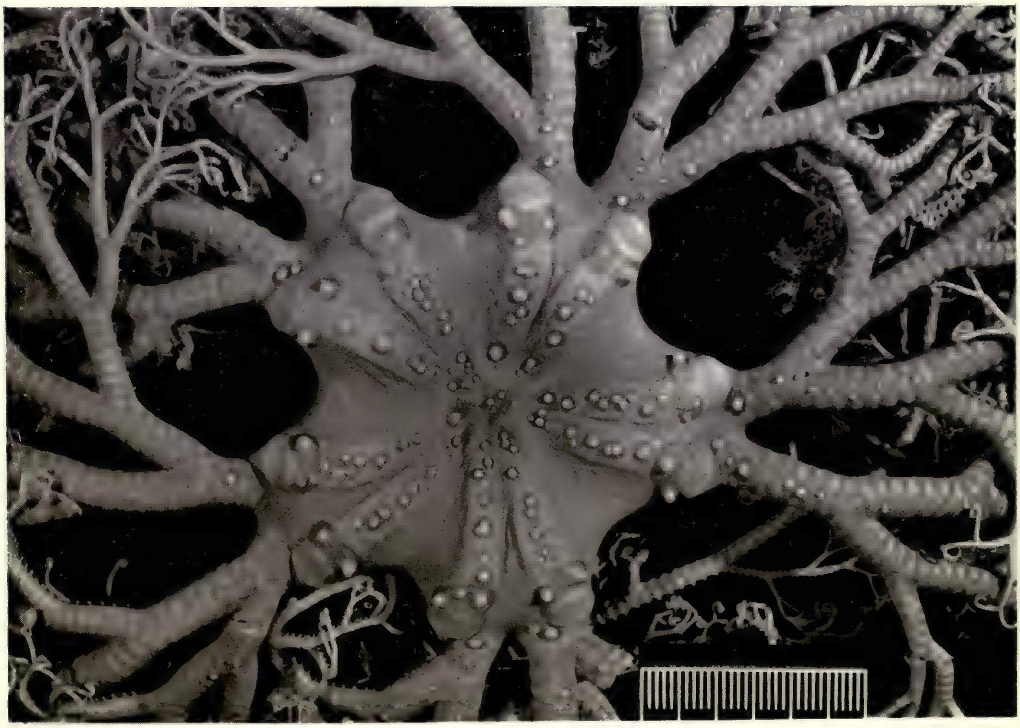

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*Printed in Great Britain by John Wright and Sons Ltd. at The Stonebridge Press, Bristol BS4 5NU*